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SUPPLEMENTARY WORK

IN

ARITHMETIC

PART I.—LINES

BY

WM. M. GIFFIN, A. M. Pd. D.

Vice-Principal, Cook County Normal School.

AUTHOR OF "CIVICS FOR YOUNG AMERICANS," ETC., ETC.

CHICAGO

A. FLANAGAN, PUBLISHER

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TO TEACHERS.

Motive. (Charts 1 and 2.) To necessitate the use of the ruler by the children. To exercise their judgment. (They should first judge the lengths of each line and then verify. In the same way objects in the room, parts of the room, etc., should be measured.) To give tests in the five fundamental operations, viz.: addition, subtraction, multiplication, division, and partition.

Too often the study of lines (Long Measure) consists in simply learning the table. Thousands have learned that 12 inches make one foot, 3 feet make one yard, 5½ yards make one rod, without ever having seen anything a rod long, knowing it to be such. The writer speaks advisedly, he having been so informed by *teachers* from nearly every State in the Union. In fact, it is at the earnest request of these teachers that he sends out this "Supplementary Work in Arithmetic," which, at best, is only a suggestion of what may be done in this intensely interesting subject. The first three years in school may be so improved as to make it possible for the children to judge distances and the lengths of objects from an inch to a chain long with almost absolute accuracy.

Charts 3, 4, and 5 review the fundamental operations, necessitate careful observation, the comparison of numbers, and make the child familiar with the names of the plane figures which everywhere surround him.

Charts 6, 7, 8, etc., continue the review and also require the child to search out his own premises, as he must do in all future

work, and to exercise his reasoning faculties *e. g.* (see Chart VI.). The teacher should require good reason for the answers given thus: If $a\,h$ is prolonged so as to meet $d\,c$ prolonged, the side $d\,c$ will then be equal to $a\,b$, hence $a\,b$ equals the sum of $h\,g$, $f\,e$, and $d\,c$, or 4 inches.

That the book, which is soon to be followed by Part Two (Area) and Part Three (Volume), will prove a help to the teachers into whose hands it may fall, is the earnest hope of the Author.

Cook County Normal School, *Dec.* 21, 1893.

SUGGESTIVE QUESTIONS ON CHART I.

How long is A ?
How long is B ?
How long is C ?
How long is D ?
How long is E ?
How long is F ?
How long is G ?
How long is H ?
How long is I ?
How long is J ?
How long is K ?

How many A's can be made of E ?
How many B's can be made of F ?
How many C's can be made of G ?

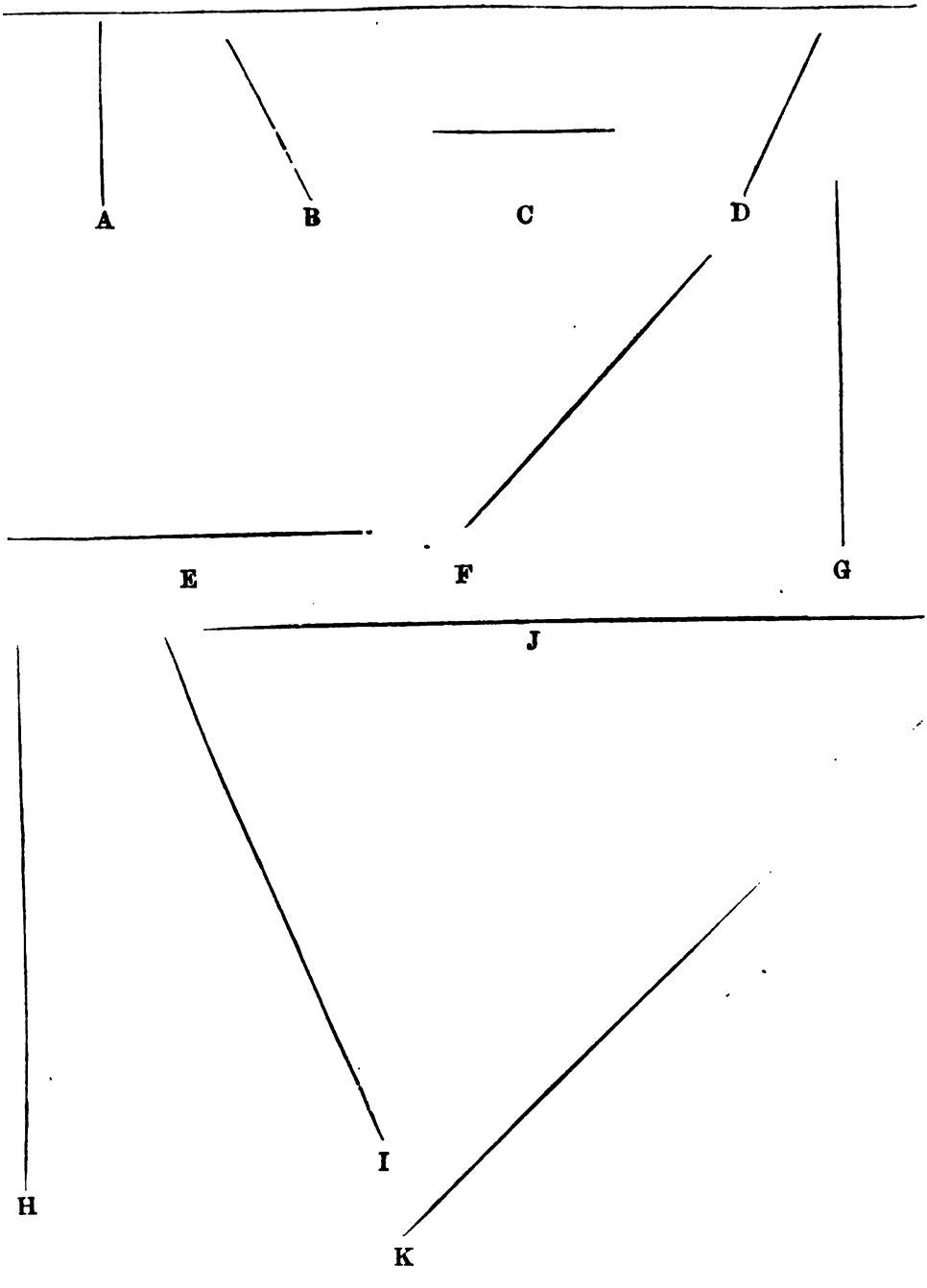
How many E's can be made of H ?
How many F's can be made of I ?
How many G's can be made of J ?
How many J's can be made of K ?

How much longer is H than A ?
How much longer is I than E ?
How much longer is K than D ?
How much longer is K than E ?
How much longer is K than J ?

How much longer is E than A and B together ?

To how many C's is K equal ?
To how many E's is K equal ?

CHART I.



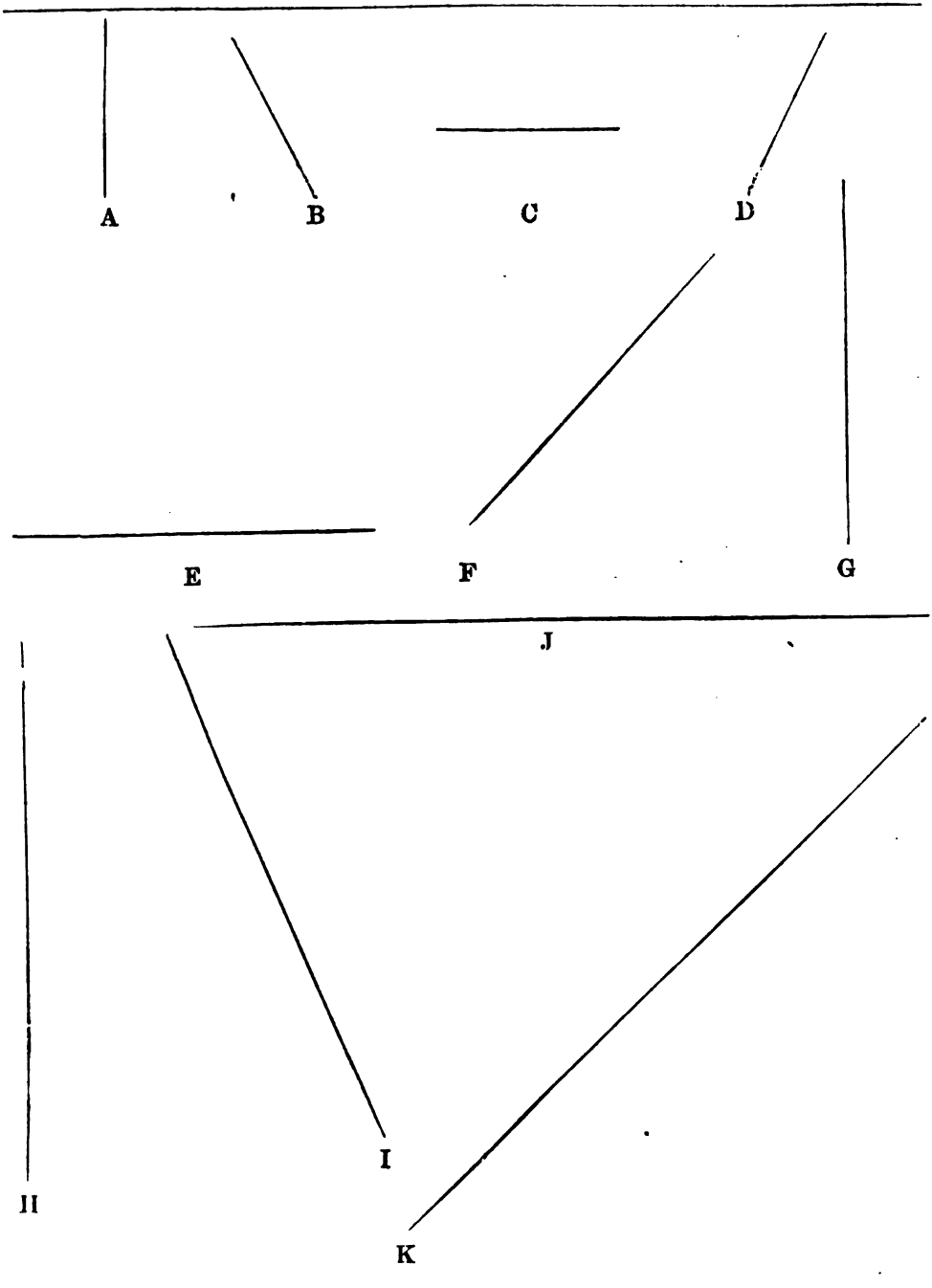
What two lines are equal to A, B, C, and D?
What one line is equal to K?
What lines are equal to K and E?
If from K we take a line equal to B what line will K then equal?
How many inches must be taken from F to make it equal to D?
How many inches must be taken from K to make it equal to C?

How many to equal E?
A is equal to what part of K?
E is equal to what part of K?
I is equal to what part of K?

A, B, C, D, and E will make a line how much longer than K?
How much longer is K, J and I than A, B, C, D, E, F and G?
What is the average length of A and J? Of C, and I?
What is the average length of B and H? Of D, and H?
What is the average length of A, E, and H? Of B, F, G?

What is the average length of A, B, E, and K?
What is the average length of H, J, C, and D?
What is the average length of K, J, B, C, and D?
What is the average length of K, H and E?
What is the average length of K, J, H, G, and I?
What is the average length of H, I, J, and K?
What is the average length of all the lines on chart I.?
When you go home to-night, get some twine and to-morrow:
Show me a string one inch long.
Show one a foot long. Show one a yard long.
Show one one-half foot long. Show one one-half yard long.

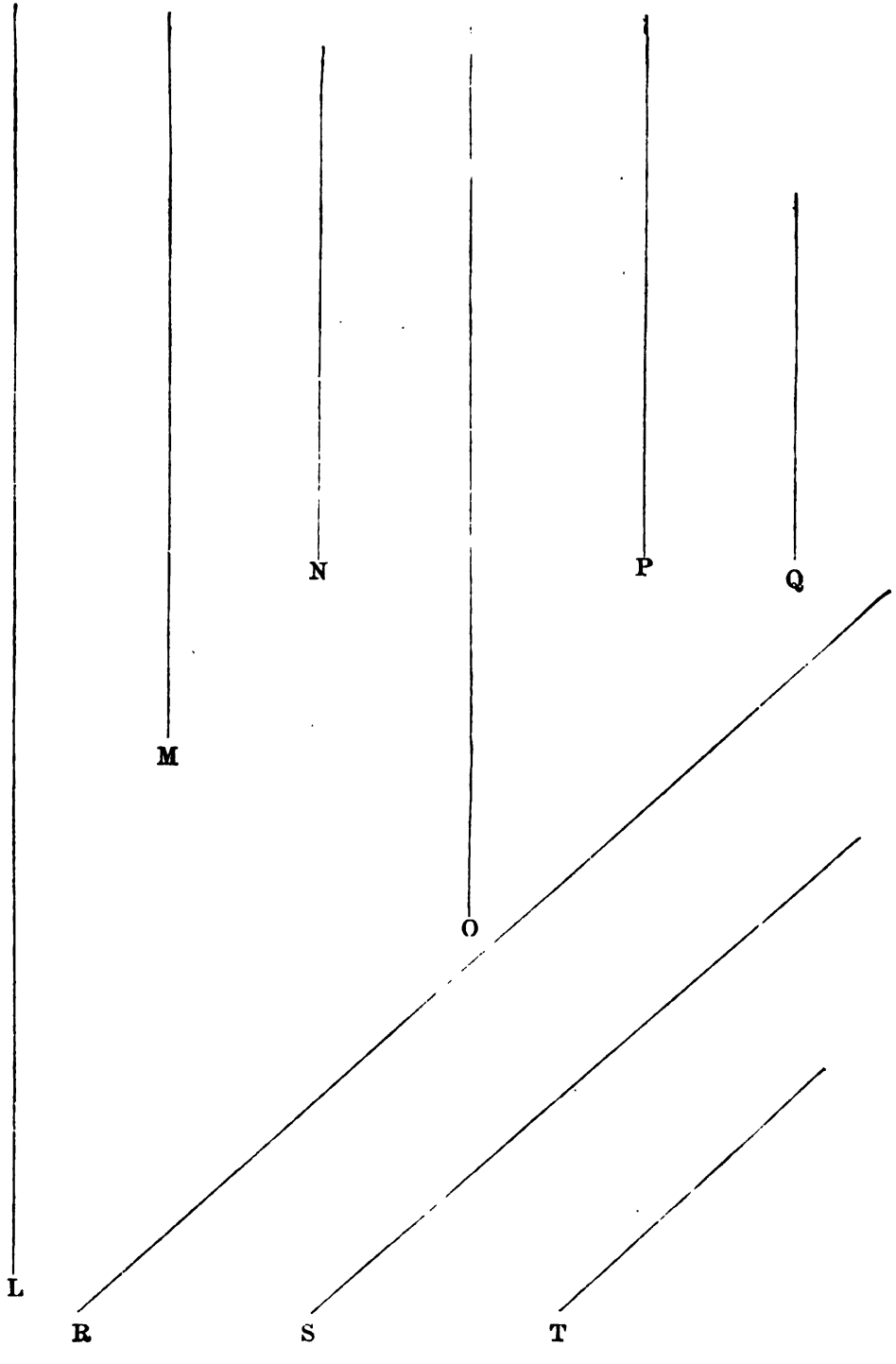
CHART I.



SUGGESTIVE QUESTIONS ON CHART II.

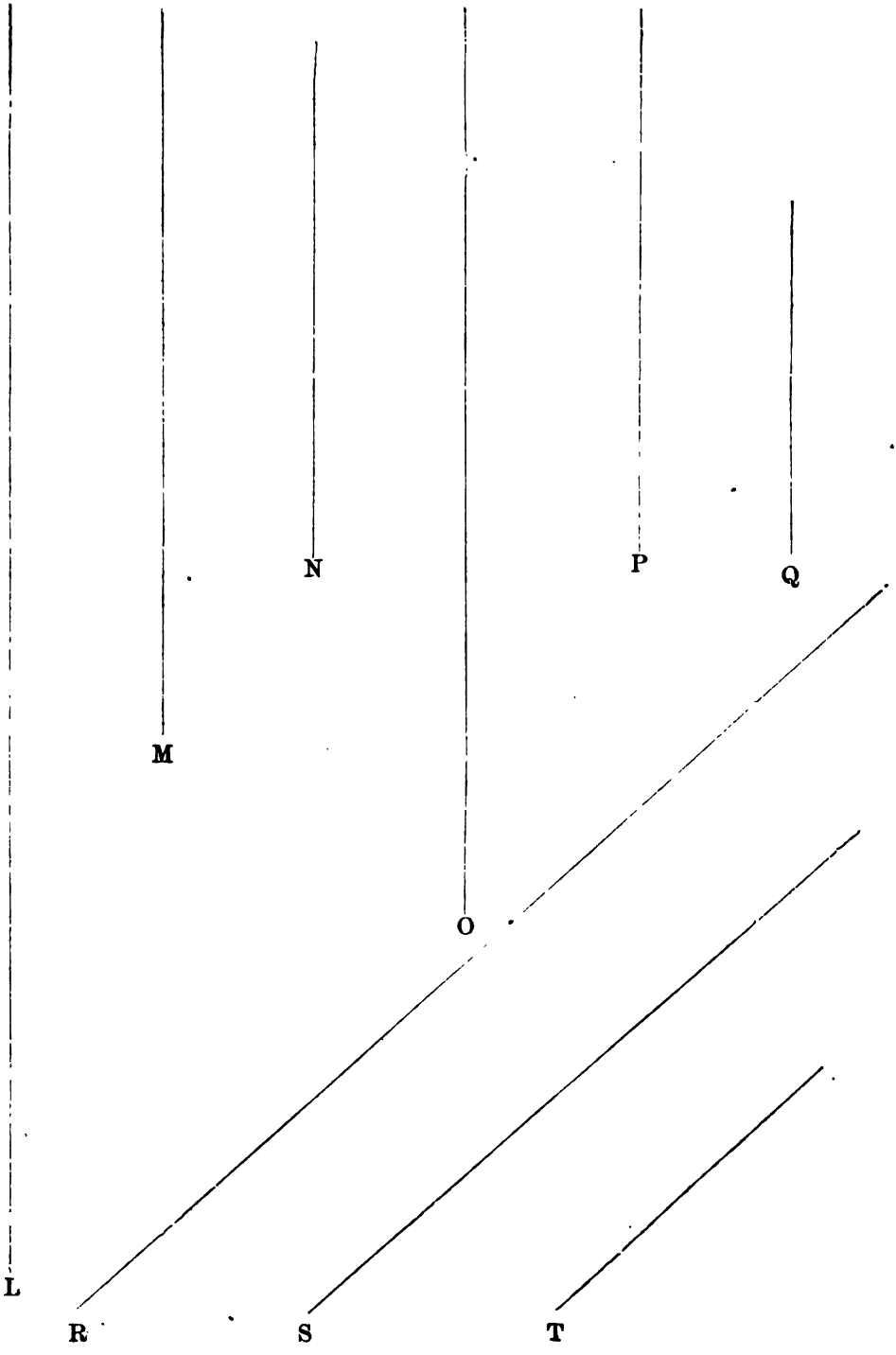
How long is O? P? Q? L? M? N? R? S? T?
What is the average length of N and O?
What is the average length of P and Q? Of R and S?
What is the average length of R, S, and T?
How does the average length of R, S, and T compare with the average length of N, O, and M?
What other three lines have the same average length?
What other three?
How many feet long are L, M, N, O, P, and Q?
What part of a yard is this?
If we add all the lines together, how many feet shall we have?
How many yards? How many inches?
What part of a foot is P?
What part of a foot is N?
What part of a foot is R? Is S?
What part of a foot is L? Is O?
What part of a foot is L if a line equal to N is taken from it?
What part of a yard is L? Is M? Is N? Is O? Is P? Is R?
What part of a yard are S and T?
Which lines added together will equal $\frac{1}{2}$-yard? $\frac{1}{4}$-yard? $\frac{1}{8}$-yard?
Which will equal $\frac{1}{2}$-foot? $\frac{1}{3}$-foot? $\frac{7}{12}$ of a foot?
How many one inches in L?
How many two inches in R?
How many three inches in Q?
How many three inches in R?
How many half-inches in P?

CHART II.



How many half-inches in O?
How many half-inches in S ?
What is the average length of M and P?
What is the average length of L, N, and P?
What is the average length of R, S, T, and O?
What is the average length of the vertical lines on Chart II ?
What is the average length of the oblique lines on Chart II ?
What is the average length of all the lines on Chart II ?
How many vertical lines are there on Chart I.?
How many horizontal lines on Chart I. ?
How many oblique lines on the two charts?
How many straight lines on the two charts?

CHART II.



SUGGESTIVE QUESTIONS ON CHART III.

LESSON I.

1. Look at Figure A. How many sides has it?
2. Are its sides equal or unequal?
3. What do we call such a figure?
4. How long are its sides? How many inches around it?
5. What is the distance around such figures called?
6. Then what is its perimeter?
7. How many $\frac{1}{4}$ inches in its perimeter?
8. How many half inches? How many one inches?
9. One side equals what part of its perimeter? Two sides?
10. Three sides equal what part? Four sides?

LESSON II.

1. What is Fig. B? How many inches in its perimeter? How many more than in figure A?

2. How many one-half inches in B's perimeter? How many one-fourth inches?

3. How many two inches in B's perimeter? To what is $\frac{3}{4}$ of its perimeter equal? One-fourth? One-half? Two-fourths? One-half equals how many fourths?

4. What is the sum of A and B's perimeters? B's less A's perimeter equals how much?

LESSON III.

1. How many sides has Fig. C? What do we call such a figure? What about its sides? What kind of a triangle is it then?

CHART III.

FIG. A.

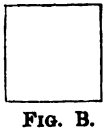


FIG. B.

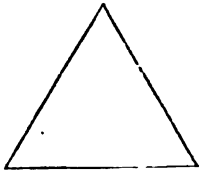


FIG. C.

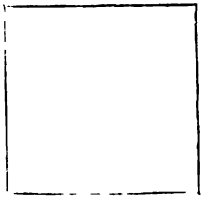


FIG. D.

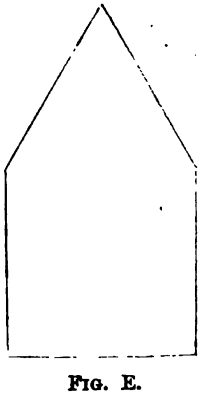


FIG. E.

2. To what is its perimeter equal?

3. One side is what part of its perimeter? Two sides? Three sides? How many thirds in a whole one?

4. How many one inches in its perimeter? How many two inches? How many three inches?

5. How many $\frac{1}{2}$ inches? How many $\frac{1}{4}$ inches?

6. To what is $\frac{1}{3}$ of its perimeter equal? Two-thirds? Three-thirds?

LESSON IV.

1. How many one inches in the sum of A, B, and C's perimeters? How many two inches? Three inches?

2. If from the sum we take A's perimeter; how many inches are left? If B is taken? If C's?

3. The sum of the three perimeters (A, B, and C.) equals what part of a foot? A's perimeter equals what part of a foot? B's? C's?

LESSON V.

1. What is figure D? How long is one side? How long is its perimeter? How much longer than C's? Than B's? Than A's?

2. How many inches in $\frac{3}{4}$ its perimeter? In $\frac{1}{2}$? In $\frac{1}{4}$? In $\frac{4}{4}$?

3. How many half inches in its perimeter?

4. One half-inch equals what part of its perimeter? Two half-inches? Three? Four? Five?

LESSON VI.

1. See figure E? How many sides has it? What do we call such a figure? What is a pentagon?

2. How long is one side? How long are its five sides?

3. How many five inches in its perimeter? How many one inches? Two? Three? Four?

CHART III.

FIG. A.

FIG. B.

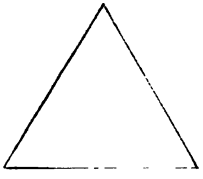


FIG. C.

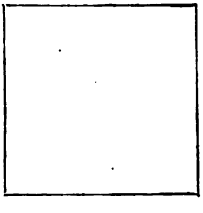


FIG. D.

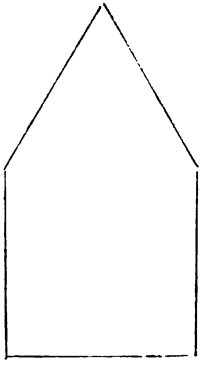


FIG. E.

4. One side is what part of its perimeter? Two sides? Three sides? Four sides? Five sides? How many fifths in a whole?

5. E's perimeter is how much longer than D's? Than C's? Than B's? Than A's?

6. E's perimeter is how much longer than B and C's together? Than A and D's?

7. E's perimeter is equal to what part of the sum of A, B, C, and D's?

LESSON VII.

1. The sum of what three perimeters is equal to a foot? Why is it a foot?

2. What part of a foot is E's perimeter?

3. What part of a foot is D's perimeter?

4. How many half-inches in E's perimeter? How many more than in D's?

5. One half-inch equals what part of E's perimeter?

6. The sum of what four perimeters equals $\frac{1}{2}$ yard? Why is it $\frac{1}{2}$ yard?

7. What part of a yard is the sum of D and E's perimeter?

CHART III.

FIG. A.

FIG. B.

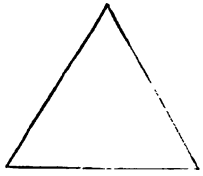


FIG. C.

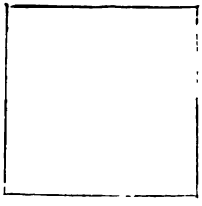


FIG. D.

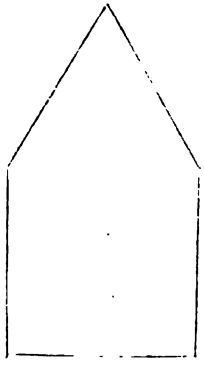


FIG. E.

SUGGESTIVE QUESTIONS ON CHART IV.

LESSON I.

1. What do we call Fig. I.? (A half-inch square.)
2. How many inches around Fig. I?
3. What do we call the distance around Fig. I? (Its perimeter.)
4. How many two inches in the perimeter of figure one? How many one inches?
5. One side is what part of the perimeter?
6. Two sides are what part? Three sides?
7. What do we call a square whose sides are twice as long as figure one?
8. How would such a square compare with figure two?

LESSON II.

1. What is the perimeter of figure two?
2. How much longer than figure one's?
3. Figure one's perimeter is equal to what part of figure two's?
4. How many one inches in figure two's perimeter? How many two inches?
5. One inch is equal to what part of figure two's perimeter? Two inches? Three?
6. Look at figure two. One inch is what part of its perimeter? One inch is what part of figure one's perimeter?
7. How many three inches in the perimeters of figures one and two taken together?

CHART IV.

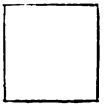


FIG. I.

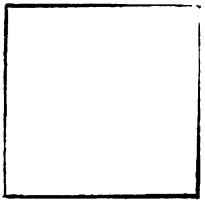


FIG. II.

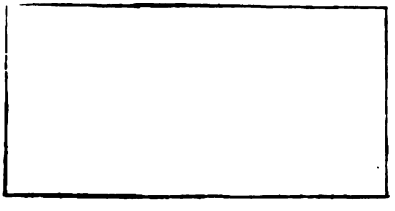


FIG. III.

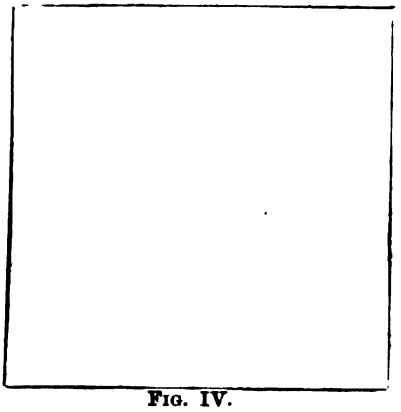


FIG. IV.

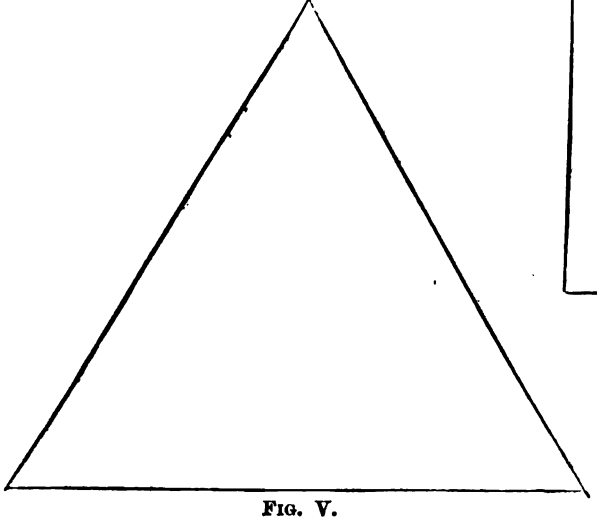


FIG. V.

8. How many two inches? How many one?

9. How many half-inches in the perimeter of figure two?

10. How many squares like figure one, can be made of the sides of figure two? How much of a line will be left over?

LESSON III.

1. How many inches around Fig. III.? What do we call figure three? The right end is equal to what part of the distance around it?

2. The upper side is equal to what part of the distance? The lower side and left end together?

3. The sum of the perimeters of figures one, two, and three equals what part of a yard? If from this sum the perimeter of figure one be taken what part of a foot will be left? How many sixths in a foot? Then how many sixths were taken?

LESSON IV.

1. What do we call Fig. IV.? How many more inches around figure four than figure three? How many of figure four's sides equal the perimeter of figure three? To the perimeter of which figure must that of figure four be added to equal one foot?

2. How many two inches in figure four's perimeter? How many four inches?

3. How do the $\frac{1}{4}$-inches in the perimeter of figure two, compare with the $\frac{1}{2}$-inches in the perimeter of figure four?

4. To what part of a yard is the sum of the perimeters of figures two, three, and four equal?

LESSON V.

1. Which is greater, the perimeter of figure four or figure five? How much greater? What do we call Fig. V?

2. One side of figure five is what part of its perimeter? Of figure four?

CHART IV.

FIG. I.

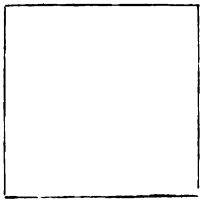


FIG. II

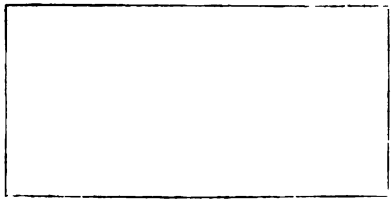


FIG. III.

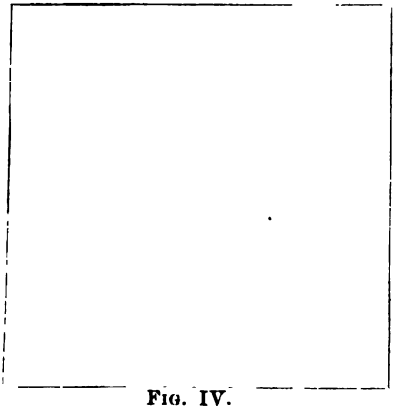


FIG. IV.

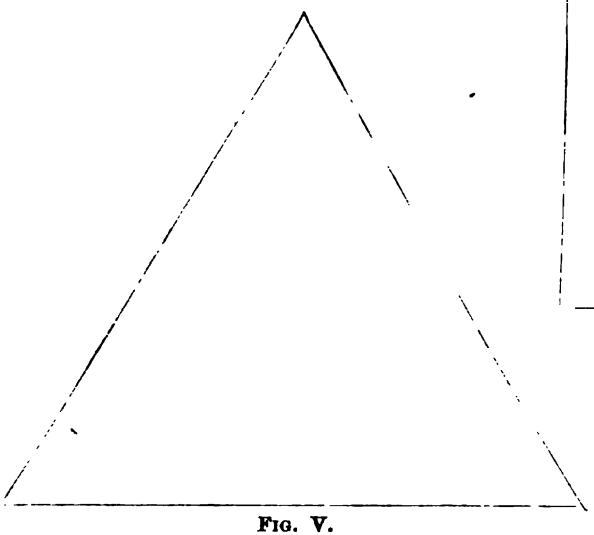


FIG. V.

3. Why is one side of figure five $\frac{1}{3}$ of its perimeter, while one side of figure four is but $\frac{1}{4}$?

4. Two sides of figure five are what part of its perimeter? Two sides of figure four?

5. The perimeter of figure five is equal to what part of a yard? Of figure four?

6. How many inches in the sum of the perimeters of figures one, two, three, four, and five? How much more than two feet is that? How many inches does it lack of a yard?

7. How many one inches is the perimeter of figure five? How many three inches? How many half-inches?

8. What is the average length of one and two's perimeter? Of twos and three's?

9. What is the average length of the perimeters of figures one, two, three, and four?

10. How long must the sides of a square be to make its perimeter seven inches? To make it nine inches? To make it eleven inches? Draw a square whose perimeter is seven inches.

NOTE.—Question on the square after it has been drawn, teaching $\frac{1}{7}$, $\frac{2}{7}$, $\frac{3}{7}$, etc.

CHART IV.

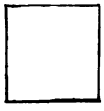


FIG. I.

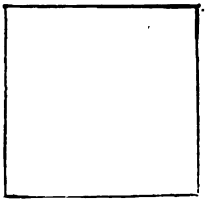


FIG. II.

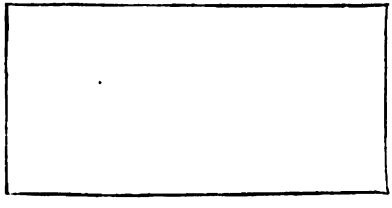


FIG. III.

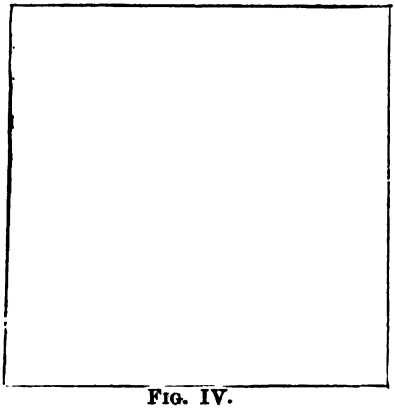


FIG. IV.

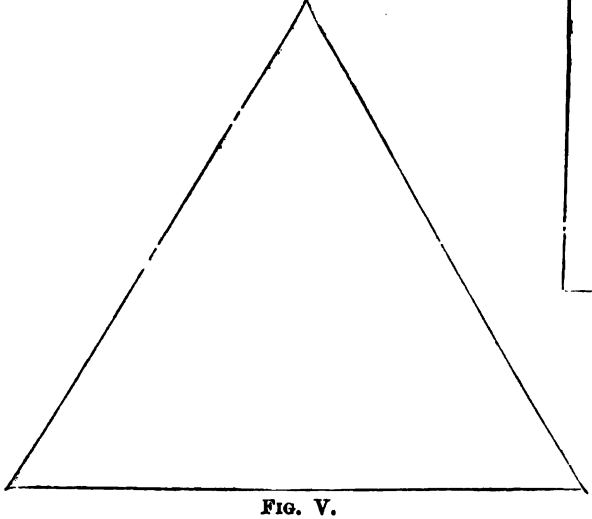


FIG. V.

SUGGESTIVE QUESTIONS ON CHART V.

LESSON I.

1. How many sides has Fig. VI.? What do we call a six-sided figure?

2. How long is one side? Then how long is its perimeter?

3. How many one inches in its perimeter?

4. How many three inches in its perimeter?

5. How many half inches in its perimeter?

6. If one side were taken away how many inches would be left? If two sides? If three?

7. What part of the perimeter would be left if three sides were taken?

8. One side is what part of the perimeter?

9. Two sides are what part of the perimeter? Or what other name might be given? Then $\frac{2}{6}$ of anything is how many thirds of it?

10. Three sides are what part of the perimeter? One-half of anything is how many sixths?

11. Four sides equal what part of its perimeter? Four-sixths of anything are how many thirds of it? Five sides are how many sixths of the perimeter? How many sixths in a whole?

12. What part of a foot is its perimeter? $\frac{9}{12}$ of anything are how many fourths?

LESSON II.

1. How many feet around Fig. VII.?

2. The upper side is what part of the perimeter? Then what part of a foot are four inches?

CHART V.

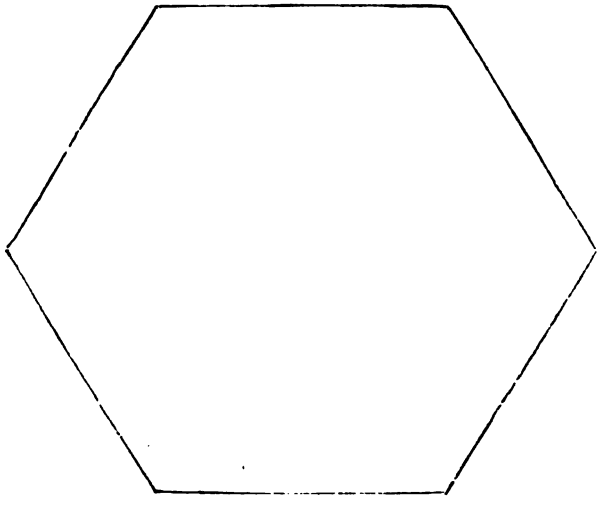


FIG. VI.

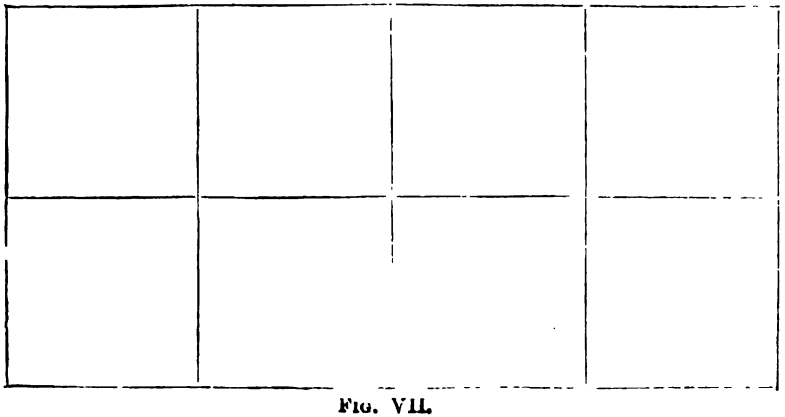


FIG. VII.

3. What part of the perimeter is one end? Then two inches are what part of a foot? Six inches are what part of a foot?

LESSON III.

1. How many small squares do you see in figure seven?
2. One square is what part of all of the squares? Two squares are what part of them all? How many $\frac{2}{8}$ do you see?
3. $\frac{2}{8}$ are how many fourths? How many fourths do you see? How many halves?
4. $\frac{1}{2}$ equals how many eighths? How many fourths?
5. One-half of one-half equals what?
6. One-half of one-fourth equals what?
7. One-fourth of one-half equals what?
8. $\frac{1}{6}$ of $\frac{3}{4}$ = ? $\frac{2}{6}$ of $\frac{3}{4}$ = ? $\frac{3}{6}$ of $\frac{3}{4}$ = ? $\frac{1}{2}$ of $\frac{3}{4}$ = ?
9. $\frac{1}{3}$ of $\frac{3}{8}$ = ? $\frac{1}{4}$ of $\frac{4}{8}$ = ? $\frac{1}{5}$ of $\frac{5}{8}$ = ?
10. $\frac{7}{8}$ equals how many fourths? How many halves?
11. In what do halves, fourths and eighths meet? (In eighths.)
12. Then $\frac{3}{4}$ of an apple, $\frac{1}{2}$ of an apple and $\frac{5}{8}$ of an apple are the same as what?

NOTE.—The same as $\frac{6}{8}$, $\frac{4}{8}$ and $\frac{5}{8}$ or $\frac{15}{8}$ or $1\frac{7}{8}$ apples.

13. If asked to work such a problem as this $(\frac{3}{4}-\frac{2}{8})$ of what are we to think?

NOTE.—We are to think of —— eighths less $\frac{2}{8}$ or $\frac{4}{8}$ or $\frac{1}{2}$.

14. $\frac{3}{4}$ and $\frac{1}{2}$ are how many?
15. $\frac{1}{4}$ and $\frac{1}{2}$ and $\frac{1}{8}$ are how many?
16. $\frac{1}{4}$ less $\frac{1}{8}$ are how many?
17. $\frac{3}{4}$ less $\frac{1}{2}$ are how many?
18. How many $\frac{1}{4}$ in $\frac{8}{8}$?

NOTE.—This is a question in division, and our dividend and divisor must be the same name. Then we must ask how many $\frac{2}{8}$ in $\frac{8}{8}$, and the answer is 4 (two-eighths.)

19. How many $\frac{1}{4}$ in $\frac{6}{8}$? How many $\frac{1}{4}$ in $\frac{1}{2}$?
20. How many $\frac{1}{8}$ in $\frac{1}{2}$? How many $\frac{1}{8}$ in $\frac{3}{4}$?

CHART V.

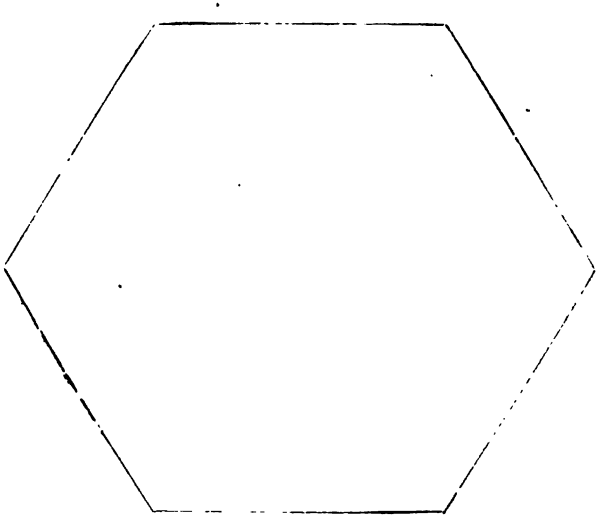


FIG. VI.

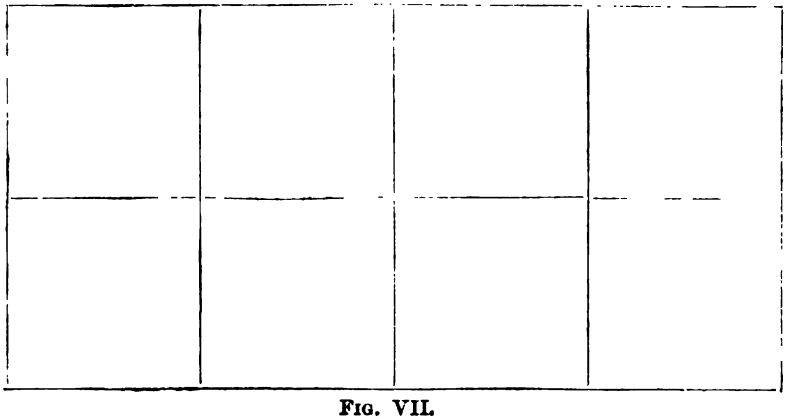


FIG. VII.

READING LESSON I.

1. Five inches and four inches are —— inches.
2. 9 inches less four inches are —— inches.
3. Seven inches and 5 inches are —— inches.
4. 12 inches less 7 inches are —— inches.
5. Five inches and seven inches are —— inches.
6. Twelve inches less 5 inches are —— inches.
7. How many four inches in 12 inches? There are —— four inches in 12 inches.
8. Three four inches are —— inches.
9. How many three inches in 12 inches? There are —— inches in 12 inches.
10. In 12 inches there are —— six inches.
11. $\frac{1}{2}$ of 12 inches are —— inches.
12. $\frac{1}{3}$ of 12 inches are —— inches.
13. $\frac{1}{4}$ of 12 inches are —— inches.
14. $\frac{1}{6}$ of 12 inches are —— inches.
15. $\frac{2}{3}$ of 12 inches are —— inches.
16. $\frac{3}{4}$ of 12 inches are —— inches.
17. $\frac{7}{12}$ of 12 inches are —— inches.
18. $\frac{11}{12}$ of 12 inches are —— inches.
19. $\frac{5}{12}$ of 12 inches are —— inches.
20. $\frac{10}{12}$ of 12 inches are —— inches.

READING LESSON II.

1. Six inches are —— of 12 inches.
2. Four inches are —— of 12 inches.
3. Three inches are —— of 12 inches.
4. Eight inches are —— of 12 inches.
5. Nine inches are —— of 12 inches.
6. One inch is —— of 12 inches.
7. Two inches are —— of 12 inches.
8. In one foot there are —— inches.
9. In one yard there are —— feet.
10. One foot is —— of one yard.
11. Two feet are —— of one yard.
12. Twelve inches are —— of one yard.
13. Twenty-four inches are —— of one yard.
14. Nine inches are —— of one yard.
15. Six inches are —— of one yard.
16. Eighteen inches are —— of one yard.
17. There are —— nine inches in one yard.
18. There are —— six inches in one yard.
19. There are —— twelve inches in one yard.
20. There are —— eighteen inches in one yard.

SUGGESTIVE QUESTIONS ON CHART VI.

LESSON I.

1.—See figure eight. How long is the line, a h ? The line, h g ? The line, f e ?

2. Without measuring find the perimeter of Fig. VIII.

3. How did you find the length of the line a b ? Of the line b c ?

4. How many lines equal to h a in its perimeter ?

5. How many lines equal to f g, in its perimeter ?

6. How many inches in the upper and lower sides ?

7. How many inches in the two ends ?

8. If the upper side be taken from the perimeter how many inches remain ?

9. If the lower side be taken from the perimeter, how many inches remain ?

10. The line h a equals what part of the perimeter ?

11. The line d e equals what part of the perimeter ?

12. Which line equals $\frac{1}{8}$ of the perimeter ?

LESSON II.

See figure IX. It is the plan of a little city.

W is Willie's home.
J is John's home.
M is May's home.
S is the school.
K is Kate's home.
H is Henry's home.
L. is Lucy's home.
Eight blocks equal a mile.

Then from W to S it is how far ?

CHART VI.

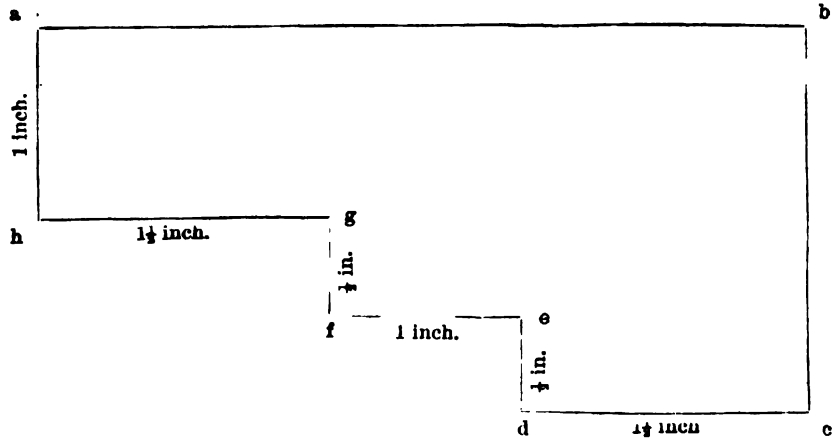


FIG. VIII.

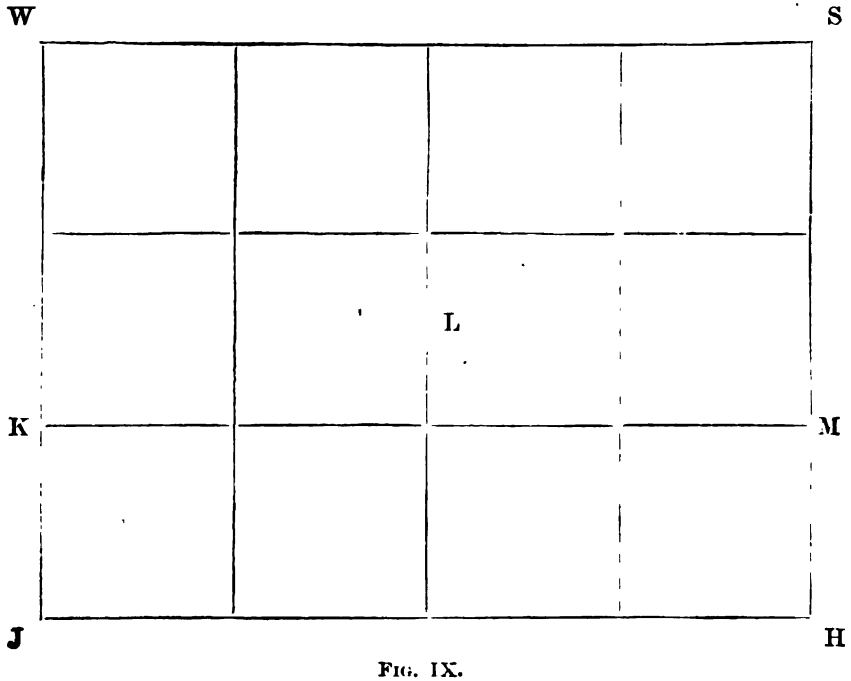


FIG. IX.

1. Willie walks how far in going to school? How far does May walk?

2. How far does Kate walk? How far Henry? How far Lucy?

3. How much farther does Kate walk than does Willie?

4. How much farther than Kate does John walk?

5. What part of a mile does May walk?

6. What part of a mile does Lucy walk?

7. Willie walked to May's *via* John's. How far did he walk? How much would he have saved if he had gone by way of the school?

8. Henry can ride on his wheel a mile in 10 minutes. How long will it take him to go to John's?

9. How long will it take Henry to ride to John's if he goes by way of the school?

10. Willie goes to the school, then to Henry's, then to John's, then back home. How far does he ride?

11. Kate rides north and follows the streets for a mile. On whom does she call? When at Willie's what part of her journey had she gone?

12. If ten blocks made a mile, how far from Willie's home to the school?

13. How far from May's home to school, if ten blocks made a mile? How far from the school to John's? To Lucy's?

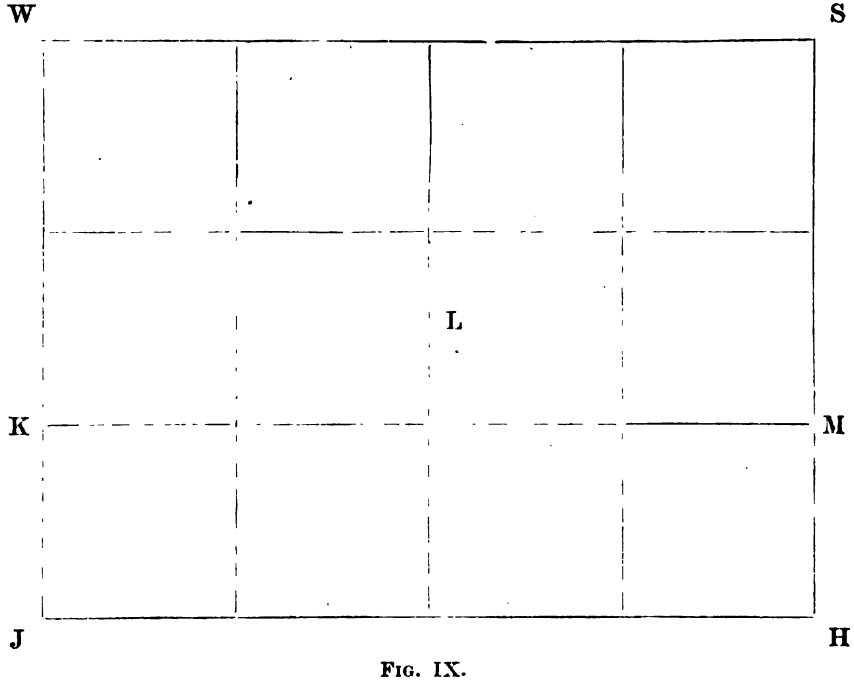


FIG. IX.

SUGGESTIVE QUESTIONS ON CHART VII.

LESSON I.

1. Find, without measuring, the length of line B C on Fig. X. Of line F G.

2. To what part of a yard is the perimeter of Fig. X. equal?

3. A B is what part of the perimeter?

4. B C is what part of the perimeter?

5. G H is what part of the perimeter?

6. How many two inches in the perimeter? How many 9 inches? How many 6 inches? How many 3 inches?

7. The line D E equals what part of the line A B?

8. The line D E equals what part of the line B C?

9. The sum of what two lines equals B C?

10. If D A be taken from the perimeter; how many inches are left? If D E? If F E? If B C?

11. How many $4\frac{1}{2}$ inches in the perimeter?

12. How many half inches in the perimeter? Can any one tell how many $\frac{1}{4}$ inches?

LESSON II.

1. In figure eleven, J is James' home, and W is Walter's; James rides to Walter's and back home. How many miles does he ride?

2. What part of the *journey* had he gone when he came to the first corner?

3. How many $\frac{1}{4}$ miles did he ride?

4. How many half miles?

CHART VII.

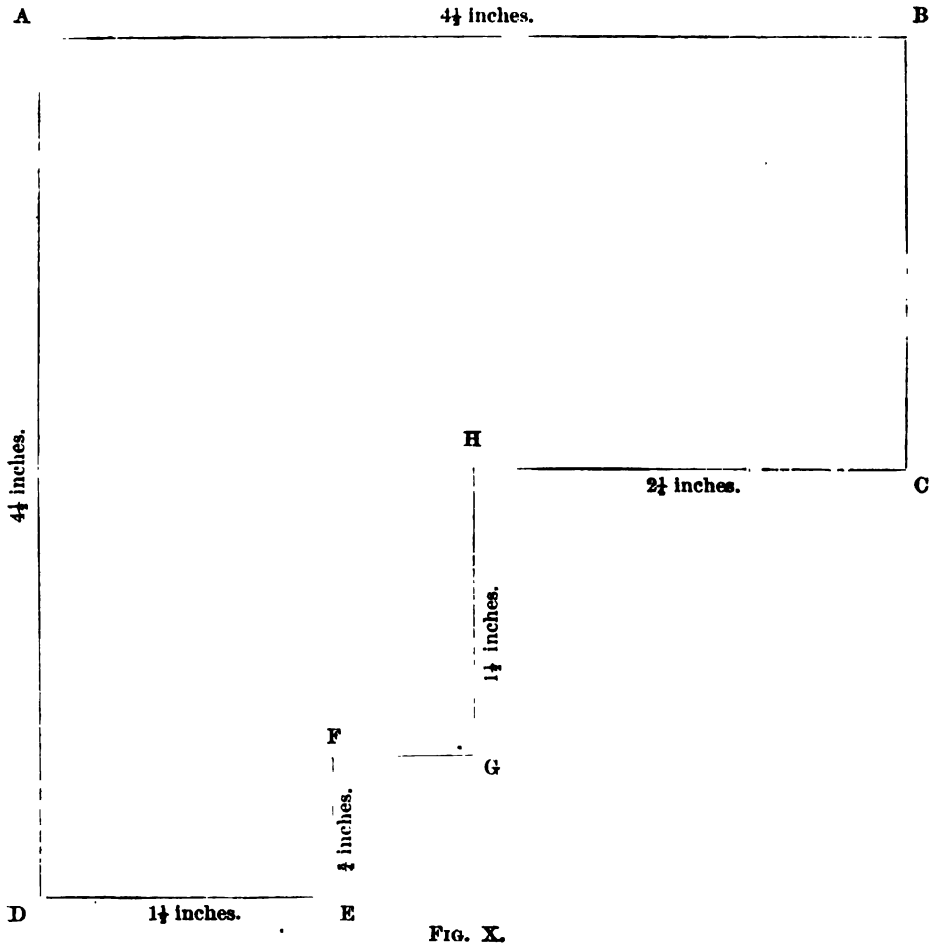


FIG. X.

5. Walter started to ride to James'. When he got to the first corner he stopped to oil his wheel. What part of the distance had he gone?

6. They are going to build a new road from Walter's *west* then north to James'. How far will it then be for the boys to ride? How much less than now?

7. How many miles will it be around the rectangle when the new road is completed?

8. John and Willie each have a wheel. Each can ride as fast as the other. Each start from home at the same time and take the old road for each other's home. Show where they will meet. How far from the N. E. corner?

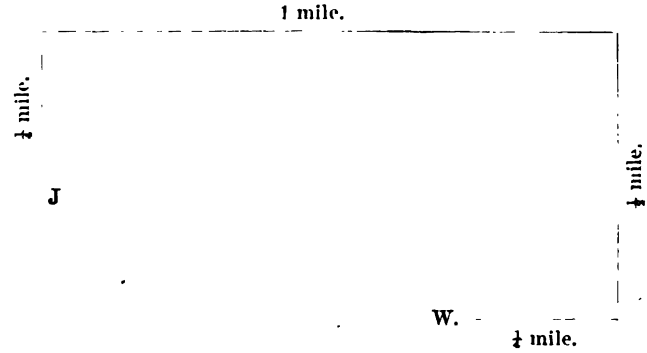


FIG. XI.

READING LESSON III.

NOTE.—Do not be guilty of talking to the child about the rod, chain and ¼ mile without measuring them, *i. e.*, have every pupil furnished with strings one rod and one chain in length.

1. In one yard there are —— feet, and in one rod there are —— yards.

2. If there are —— yards in one rod there must be —— feet in one rod.

3. A surveyor's chain is —— rods long. There are —— feet in a rod; hence there are —— feet in a surveyor's chain.

4. Since there are —— feet in a chain, there are —— feet in one-half chain.

5. In one-half chain there are —— rods. In one-fourth mile there are —— chains.

6. Have you ever measured one-fourth mile? —— I —— measured one-fourth mile.

7. Since 20 chains make one —— mile, —— chains make one mile. Then there must be —— rods in a mile.

8. One rod is —— of a chain. Two rods are —— of a chain, and three rods are —— of a chain.

9. One yard is —— of a rod and one foot is —— of a rod.

10. One-half rod equals —— yards or —— feet.

11. There are —— yards in a chain, and —— half yards make a chain.

12. Eleven feet equal —— of a chain, and —— feet equal ½ of a chain.

13. It takes —— yards to make one-half chain.

14. Two and three-fourths yards are equal to —— of a rod.

15. Eight and one-fourth feet are equal to —— yards or —— of a rod.

16. One chain and one rod equal —— yards.

17. One rod and one yard equal —— feet.

18. If from a string one chain long a piece $16\frac{1}{2}$ feet long is cut there will be —— rods left.

19. If from a string one rod long I cut three feet there will be —— yards left.

20. There are —— chains in one-half mile. In $\frac{3}{4}$ of a mile there are —— chains.

NOTE.—Though the chain is not now in common use, it enables one to give so many interesting exercises the author has thought best to use it. A 4-rod string being very convenient to measure $\frac{1}{4}$ mile, or to lay off an acre. See Part II. on Area.

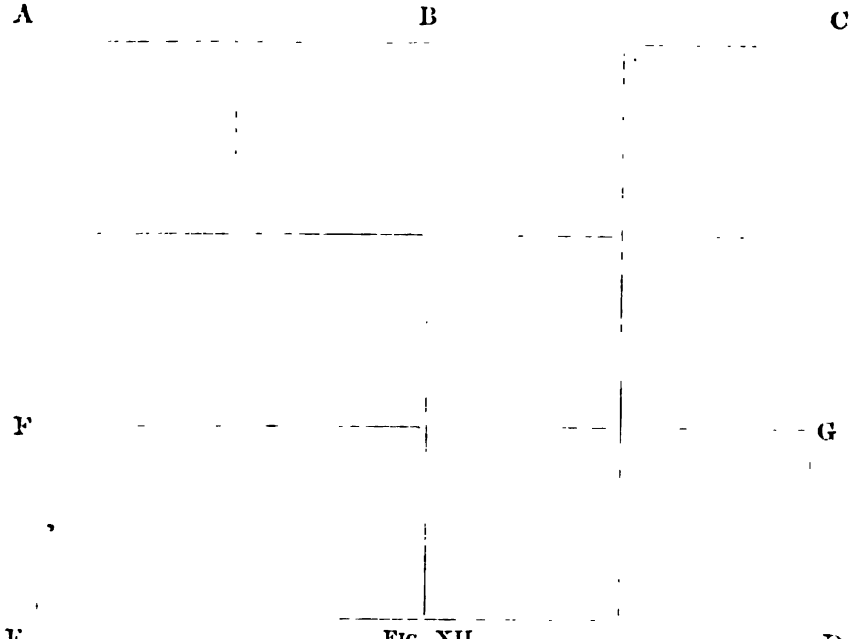


FIG. XII.

SUGGESTIVE QUESTIONS ON CHART VIII.

LESSON I.

1. See Fig. XII. If A B represent 1 chain, how many times must a man walk around the rectangle to walk one-fourth mile?

2. Where would he stop if he began his journey at A?

3. How far is it from G to F *via* D? How far *via* C?

4. How many squares do you see in figure twelve? One square is what part of them? Two squares? Three? Four?

5. How many halves do you see? How many twelfths in each half? Then $\frac{1}{2}$ equals how many twelfths?

6. How many thirds do you see? How many twelfths in each third? Then $\frac{1}{3}$ equals how many twelfths? Two thirds? Three thirds?

7. How many fourths do you see? How many twelfths in each fourth? Then $\frac{1}{4}$ equals how many twelfths? $\frac{2}{4}$? $\frac{3}{4}$? $\frac{4}{4}$?

8. If, then, we are to add $\frac{1}{3}$ and $\frac{1}{4}$, what shall we do? We say $\frac{1}{3}$ is $\frac{4}{12}$ and $\frac{1}{4}$ is $\frac{3}{12}$ and $\frac{4}{12}$ and $\frac{3}{12}$ are $\frac{7}{12}$.

9. John had $\frac{1}{6}$ of an apple, May had $\frac{2}{3}$ and Will had $\frac{3}{4}$. How much did they all have?

10. How many oranges are $\frac{2}{3}$ and $\frac{1}{2}$ of an orange?

11. Will had $\frac{3}{4}$ of an apple and gave Jennie $\frac{2}{3}$ of it. How much did he give Jennie? He gave Jennie $\frac{2}{3}$ of $\frac{3}{4}$, or $\frac{?}{12}$. $\frac{1}{3}$ of $\frac{9}{12}$ equal $\frac{?}{12}$ and $\frac{2}{3}$ equal 2, $\frac{?}{12}$ or $\frac{?}{12}$.

12. Henry has $\frac{1}{3}$ of a pie and gives May $\frac{1}{3}$ of it. What part of a pie does May receive?

13. Cleon has $\frac{2}{3}$ of a pie. To how many boys can he give $\frac{1}{6}$? To as many boys as there are $\frac{1}{6}$ in $\frac{2}{3}$ or $\frac{2}{12}$ in $\frac{?}{12}$, which are $4(\frac{2}{12})$. Hence he can give $\frac{1}{6}$ to —— boys.

CHART VIII.

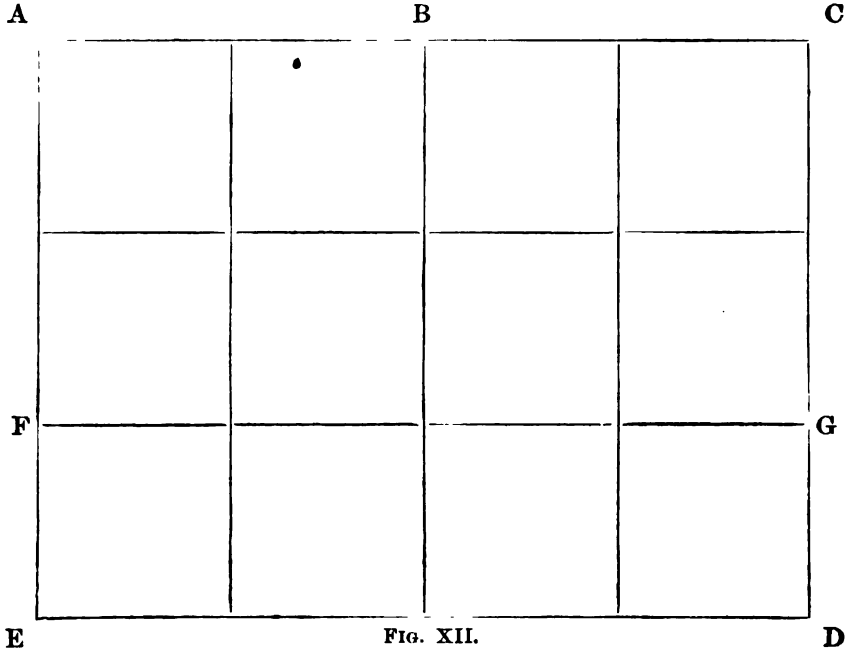


FIG. XII.

Scale, 4 feet to 1 inch.

FIG. XIII.

14. John had $\frac{3}{4}$ of a pie and gave Isaac $\frac{1}{3}$ of a pie. How much had he left?

15. $\frac{5}{6}$ less $\frac{2}{3}$ equal what?

16. $\frac{1}{3}$ of $\frac{3}{4} = ?$ $\frac{1}{4}$ of $\frac{2}{4} = ?$ $\frac{1}{2}$ of $\frac{5}{6} = ?$

17. How many boys may be given $\$\frac{1}{6}$ by a man who has $\$\frac{1}{2}$?

18. $\$\frac{2}{3} \div \$\frac{1}{6} = ?$ $\$1\frac{2}{12} \div \$\frac{1}{3} = ?$ $\$1 \div \$\frac{1}{3} = ?$

19. $\frac{1}{6}$ of $\frac{2}{3} = ?$ $\frac{1}{3}$ of $1\frac{2}{12} = ?$ $\frac{1}{3}$ of $\$1 = ?$

20. $3\ \frac{2}{3}$'s $= ?$ Three $\frac{3}{4}$'s $= ?$ Four $\frac{2}{6}$'s $= ?$

LESSON II.

1. To what is the perimeter of the lot of which Fig. XIII. is a plan equal? How long is one side? One end?

2. How many 12-foot boards must be used to build a fence around the lot 5 boards high?

3. How many posts must be used if placed 6 feet apart?

4. How many feet of barb wire to go once around it? How many yards to go 10 times around it?

5. One man had such a lot and used 16-foot boards, placing his posts 8 feet apart and using but one on each end. How many boards did he use to build it 6 boards high? 27 ans.

6. If the scale were 4 chains to 1 inch, what part of a mile would the perimeter equal?

7. If we desired the perimeter to represent just one mile, what scale would we use?

8. If 1 inch equal $4\frac{1}{3}$ chains, how many chains long would the two ends be? The two sides?

9. If the scale was 1 inch to $5\frac{1}{2}$ yds., how many rods in the perimeter?

10. If the scale were 1 inch to 33 feet, how many chains in the perimeter?

SUGGESTIVE QUESTIONS ON CHART IX.

LESSON I.

1. In Fig. XIV. A B represents a road (being drawn on a scale of $\frac{1}{2}$ inch to 40 rods). Thomas rides his pony from A to B and then back to A again. How many miles does he ride?

2. What part of a mile from A to B?

3. One-half the distance from A to B is what part of a mile?

4. See figure fifteen, where the scale is $\frac{1}{2}$ inch to $\frac{1}{8}$ mile. Mr. Johnson lives at B. The post-office is at C. He goes to the office for his mail and starts directly home again. When he has walked one mile how many rods is he from home?

5. How many chains is it from B to C? How many yards? How many feet?

6. How much farther is it from B to C than from A to B?

7. The distance A B equals what part of the distance B C?

8. Why is six-sevenths the answer?

9. One-half the distance A B equals what part of $\frac{1}{2}$ the distance B C?

10. One-seventh of the distance B C equals what part of the distance A B?

LESSON II.

1. How many 12-foot boards must be used to fence a lot like one shown by figure sixteen if the fence is five boards high?

2. If I used $\frac{1}{5}$ less boards, how many boards high would the fence be?

3. How many posts would be required if placed 6 feet apart?

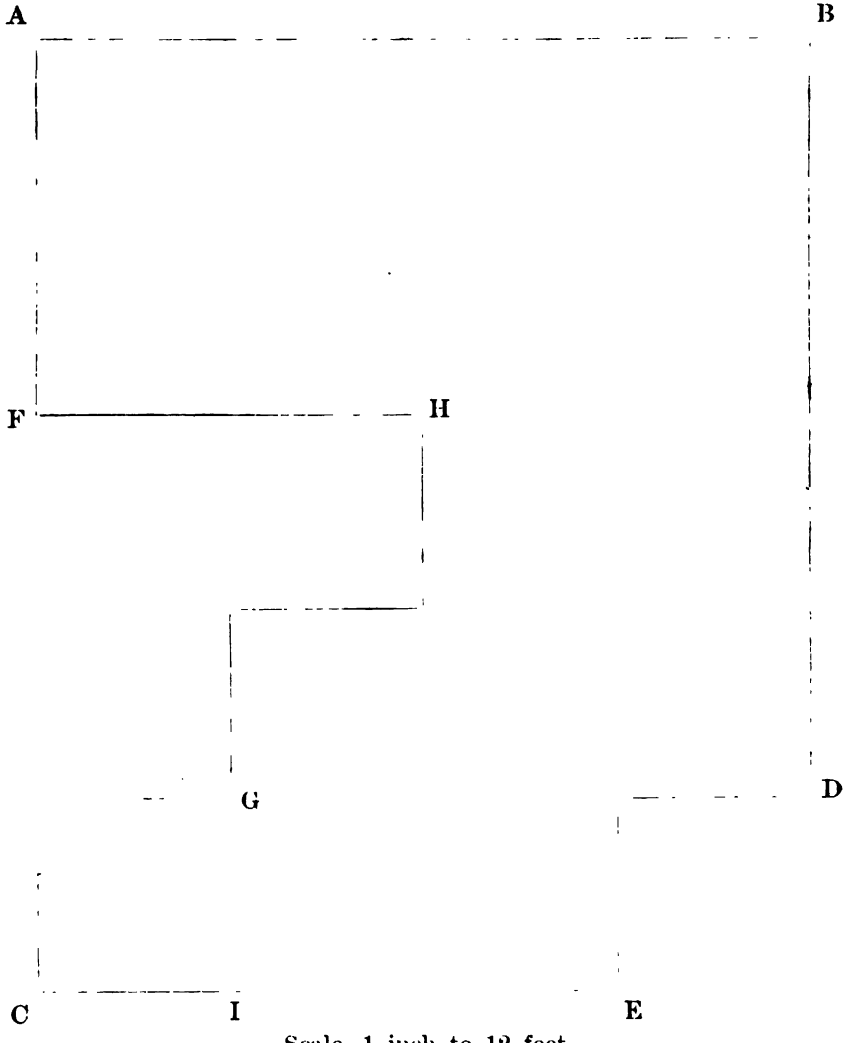
CHART IX.

A B

FIG. XIV.

B C

FIG. XV.



Scale, 1 inch to 12 feet.

FIG. XVI.

4. How many boards would be used if the north side were left open?

5. How many feet of wire would it take to fence the lot three wires high? How many rods is that?

6. How many pickets 4 inches wide, and placed 2 inches apart, would be used in fencing it?

7. How many feet of studding would be used in making the picket fence?

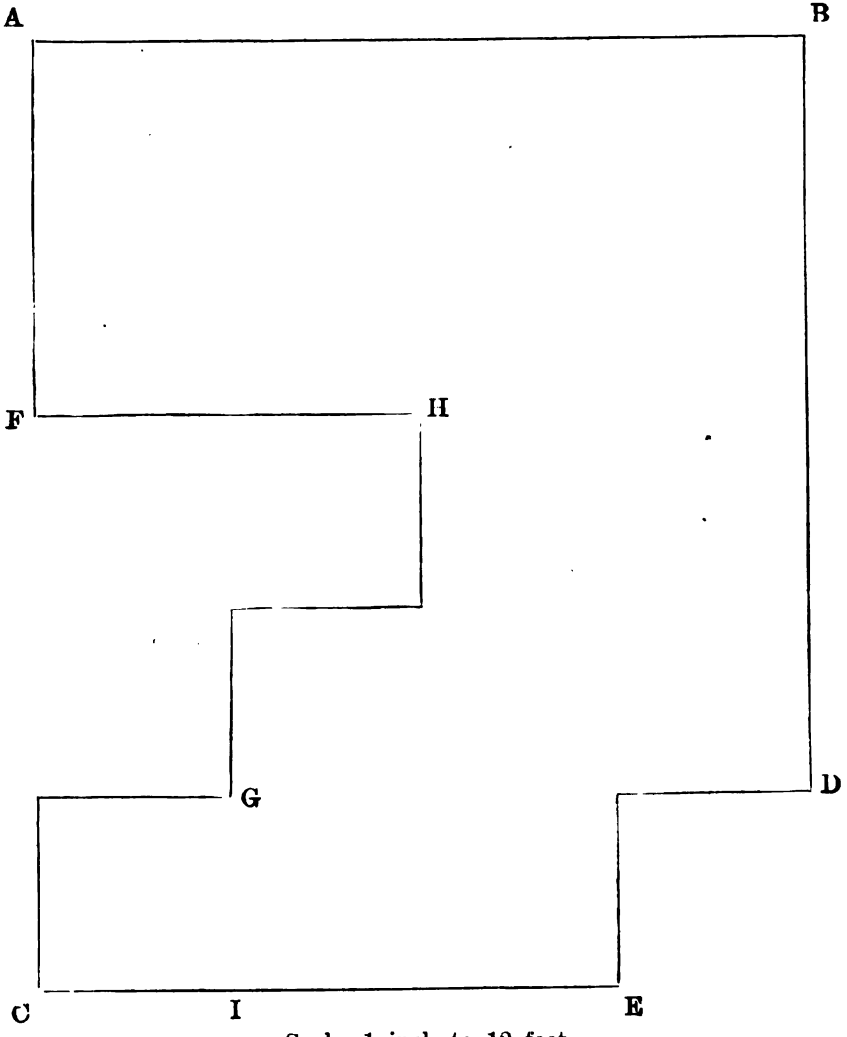
8. Why 528 feet, since it is but 264 feet around the lot? What is $\frac{1}{12}$ the distance around the lot? $\frac{3}{12}$? $\frac{7}{12}$? $\frac{11}{12}$?

9. If the scale were 1 inch to 12 miles, how far from D to G *via* E?

10. How much would be saved if a road ran straight from D to G?

11. If $\frac{1}{16}$ inch equaled a mile, how far from D to H in direct line?

12. How far by way of B? By way of E?



Scale, 1 inch to 12 feet.

FIG. XVI.

SUGGESTIVE QUESTIONS ON CHART X.

LESSON I.

1. In the stairs, figure seventeen, A B equals 8 inches and B C equals 8 inches. How many yards of carpeting will it take to cover the whole stairs?

2. What part of the carpet will it take for A B? A B and B C?

3. If A B and B C each equaled six inches, how many yards of carpet would it take?

4. How many inches in the perimeter of figure eighteen?

5. One inch is what part of the perimeter?

6. If one inch is .1, how many tenths are two inches?

7. How many fifths are two inches? Then one-fifth is how many .2?

8. How many inches are .3? How many inches are .4? And .4 are how many fifths? How many inches are .6 of the perimeter?

9. Six tenths are how many fifths? .8 are how many $\frac{1}{5}$?

10. .9 are how many inches? Where do fifths and tenths meet? How many $\frac{2}{5}$ in .8? How many $\frac{1}{5}$ in .6?

11. If .2 of the perimeter were taken away, how many inches would be left?

12. If both ends are taken how many tenths are left?

13. $\frac{1}{5}$ less .2 = ? .8 less $\frac{2}{5}$ = ? .9 less $\frac{4}{5}$? $\frac{1}{2}$ of .4 are how many tenths? How many fifths?

14. $\$\frac{1}{5}$ and $\$.2$ are how many tenths dollars? $\$.4$ are how many cents? Then how many hundredths of a dollar are .4? Where do tenths and hundredths meet?

CHART X.

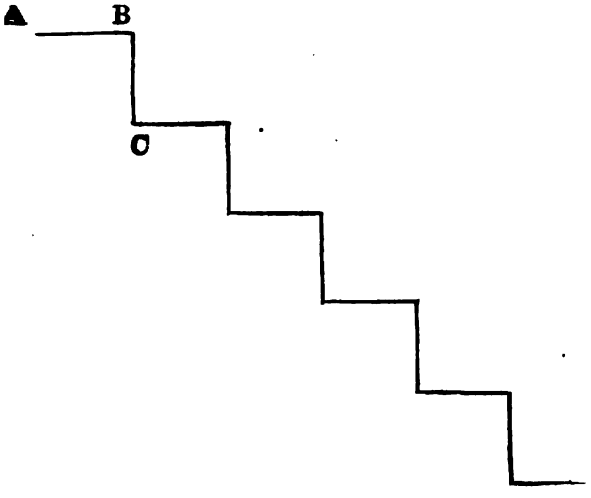


FIG. XVII.

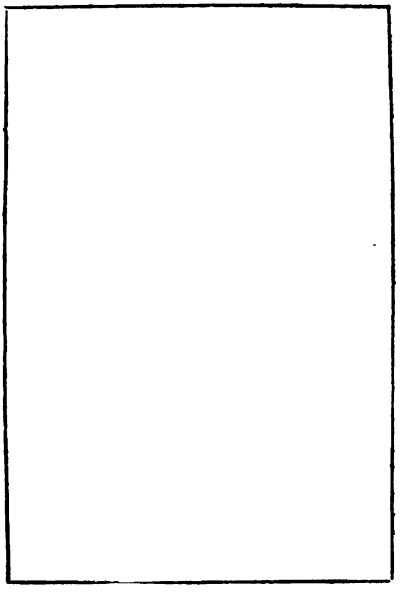


FIG. XVIII.

LESSON II.

1. Figure XVIII. is the plan of a room, drawn on a scale of $\frac{1}{8}$ inch to 1 foot. How many feet of picture moulding will it take to go around the room?

2. On this moulding are to be hung two pictures on each side and one on each end. If six feet of wire are used to hang each picture, how many yards of wire will it take?

3. How many 16-foot boards, 4 inches wide, will it take to lay the floor of the room?

4. The room is 10 feet high. In the center of the room there is to be a gas fixture. It is to be six feet four inches from the floor. How long will it be?

5. In the middle of the north end of the room there is a window. How many feet is it from the corner to its center?

6. Eight feet from the southeast corner there is another window. How many feet is it from the northeast corner? From the southwest corner?

7. There is an extension table in the room. When the leaves are out it is 4 feet long. There are 6 leaves, each 16 inches wide. When all the leaves are in the table and it is in the center of the room, how many feet between its ends and the ends of the room?

8. The table is 4 feet wide. How many feet between its sides and the sides of the room?

9. How many people can sit at this table, allowing two feet for each person?

10. If two persons are excused from the table, what part of the company is excused? If three are excused? If 4? If 5?

LESSON III.

1. Willie had a toy railroad. Fig. XIX. shows it drawn on a scale of one inch to a rod. How many rods of rails did it take to build it? What do we call as many eggs? As many months? As many inches? As many dozen?

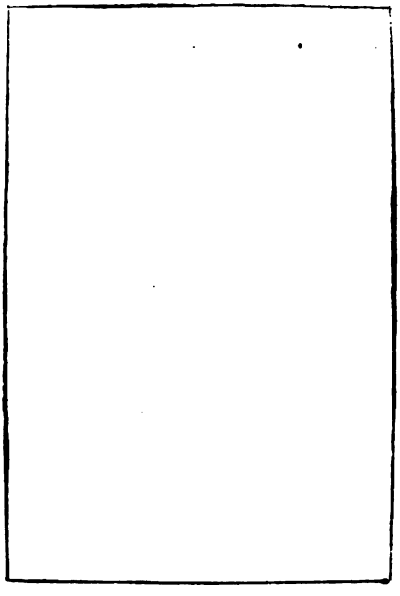


FIG. XVIII.

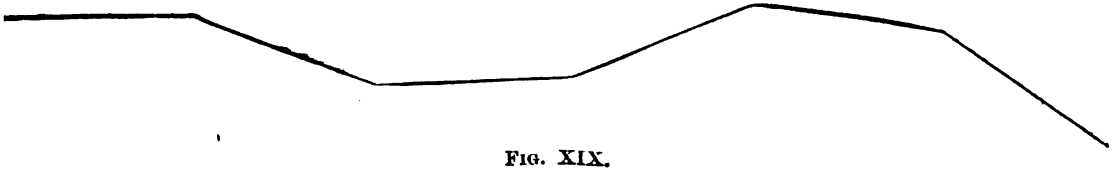


FIG. XIX.

2. How many yards of rails were in the railroad? How many feet? How many chains?

3. The railroad ties were placed 3 feet apart. How many were used in building the railroad?

4. The rails were 9 feet long. How many were used?

5. Two spikes were driven in each end of each tie. How many spikes were used?

6. Figure twenty is another railroad. How many miles of rails were used to build it? How many chains? Rods?

7. A, B, C and D are stations. C is a junction. How far from A to the junction? From D?

8. A B is what part of the distance A C? What part of A D? A B equals what part of B D?

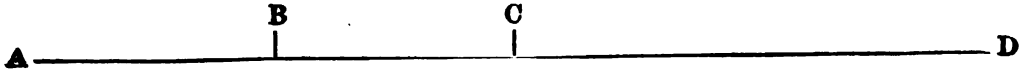
9. How many more rods of rails from B to D than from C to D?

10. Take A B from A D and what part of a mile is left? How many chains? Rods?

11. How many A B's in A D? In A C? $\frac{1}{2}$ of A B equals what part of A D?

12. $\frac{1}{2}$ of A B equals what part of A C? Of B C? Of C D? Of B D?

FIG. XIX.



Scale, $\frac{1}{16}$ inch to 1 chain.

FIG. XX.

SUGGESTIVE QUESTIONS ON CHART XI.

LESSON I.

1. Two men, B and C, start to walk from the same place, which we will call A. When B has walked 4 miles directly north and C has walked three miles directly west they both stop to rest. How near are they to each other while resting? Let us draw a diagram (see Fig. XXI.) showing their positions, using a scale of 1 inch to 1 mile. Then the line A B must be 4 inches long to represent 4 miles and the line A C must be three inches long to represent the three miles. It follows, then, that the line B C must also be on the same scale. We will draw the line and find it is —— inches long. Hence the answer is —— miles.

2. When the line B C is drawn, what kind of a figure have we? What do we call the side A B? A C? B C? What kind of a triangle is A B C? Why a right-triangle?

3. If B had walked 8 miles and C had walked 6 miles, what would have been the answer? Draw a diagram.

4. Figure XXII. is the end plan of a house. How long must the rafters be for the roof if they project 6 inches and the height of the roof from the center of the building is to be 12 feet, as shown by the dotted line?

5. If boards 4 inches wide and 16 feet long are put on the roof 2 inches apart, how many boards will be required? The roof, with projections, is to be 24 feet long.

6. George was flying his kite when it became fastened in the top of a tree. His kite-string was five rods long and the distance from the point where his string touched the ground to the bottom of the tree was 4 rods. How high was the tree? In this problem we have given the

CHART XI.

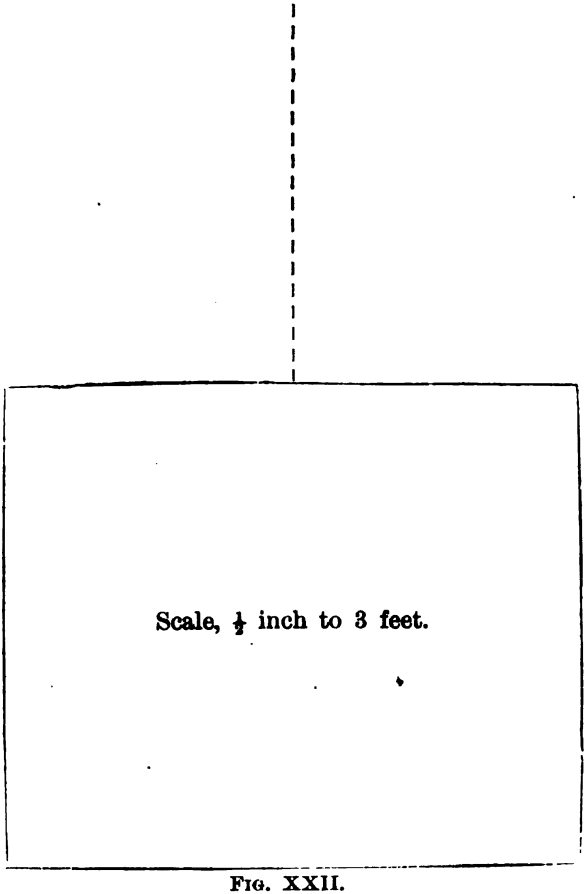


FIG. XXII.

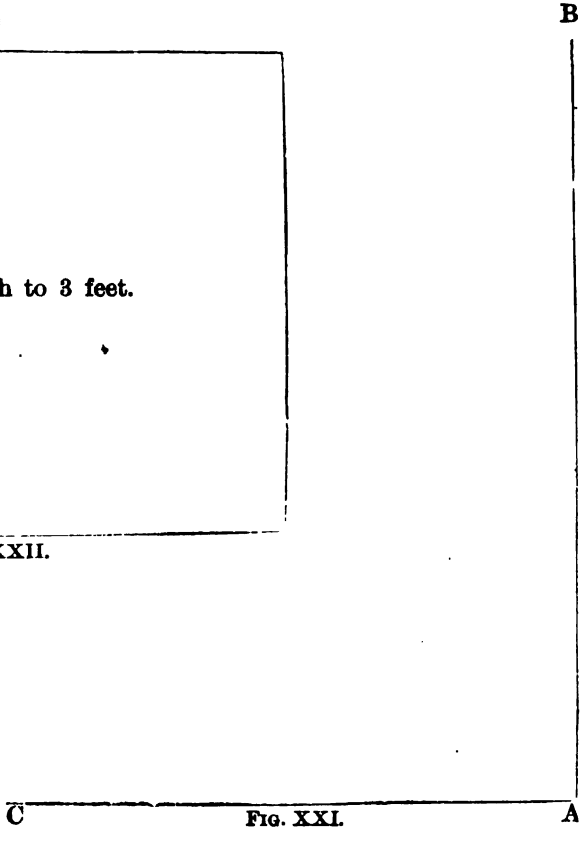


FIG. XXI.

base of the triangle (4 rods) and the hypotenuse (5 rods) and are to find the perpendicular. We will draw a diagram, using a scale of 1 inch to a rod. First represent the tree of indefinite height. From this line draw the base, 4 inches long. Next take a pair of dividers and set them just 5 inches apart. Place one point on the end of the base farthest from the tree, and with the other point cut the line representing the tree. From this point to the other end of the base is the height of the tree (see Fig. XXIII.). By measuring we find that this line is —— inches long. Hence the tree is —— rods high. How many feet is that? How many yards? What part of a chain? What part of a mile?

NOTE.—Remember that when working these problems we draw right-triangles. Be sure your angle opposite the hypotenuse is a right-angle. Careless pupils will make errors here and hence never get the correct answer. See Note Page 87.

7. A man starts from a given point and walks east 12 chains. He then ascends in a balloon 16 chains. How far is he from the starting-point, shortest distance? Draw a diagram on a scale of $\frac{1}{2}$ inch to a foot.

8. A man desired to know the height of a ceiling. He had a pole 30 feet in length, but this was too long. He placed one end of the pole against the side of the wall so as to touch the ceiling and found the other end was 18 feet from the side of the wall. From this how could he find the height of the ceiling? (Draw a diagram on a scale of 1 inch to 3 feet.)

9. The rope fastened to the top of a flagstaff was 35 yards long. When pulled out at full length it touched the ground 21 yards from the foot of the staff. How many feet high was the staff?

10. Three boys had a string. John had one end and Will took hold of the other end and 24 feet east of John he stopped, giving the end to Henry, but keeping hold of the string just 24 feet from John's end. Henry went north from Will 32 feet where he passed the string around a post and then took the end to John straight from the post. How long was the string?

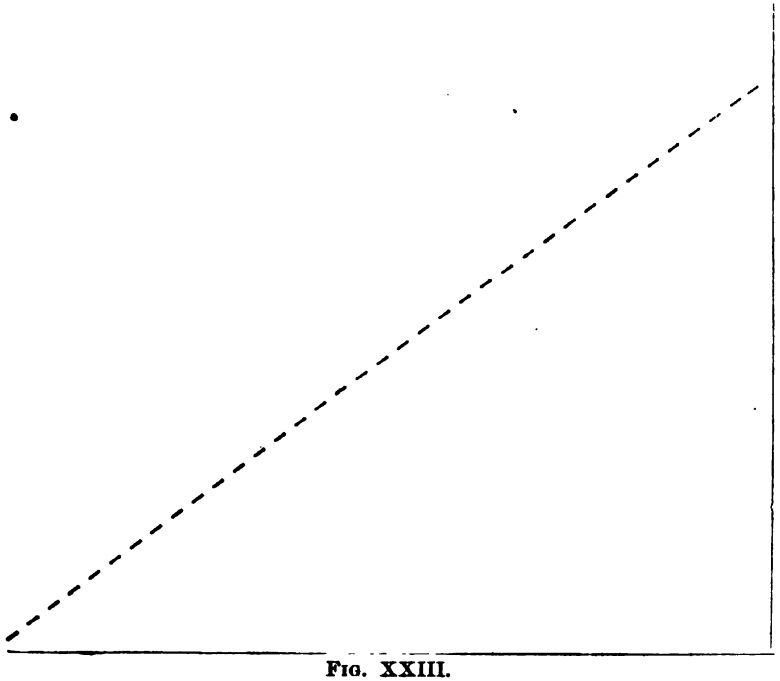


FIG. XXIII.

SUGGESTIVE QUESTIONS ON CHART XII.

LESSON I.

1. How long would a rope have to be to reach around Fig. XXIV.?

2. The distance from c to h is equal to what part of the distance from a to c?

3. Four times the distance from d to i is equal to how many feet?

4. Two-thirds of the distance around Fig. XXIV. is equal to how many yards?

5. The distance from b to c, plus the distance from d to h, plus the distance from a to b, is what part of the distance around the whole figure?

6. Three-fourths of the distance from a to c is how much less than the distance from b to j?

7. How many 18 inches are there from b to one-third of the distance from h to i?

8. The distance around Fig. XXIV. is equal to how many times the distance from c to h?

9. Which is the greater, the distance from e to j or from a to c?

10. Four-elevenths of the distance from b to i is equal to what part of the distance from a to d? What part of a yard is it?

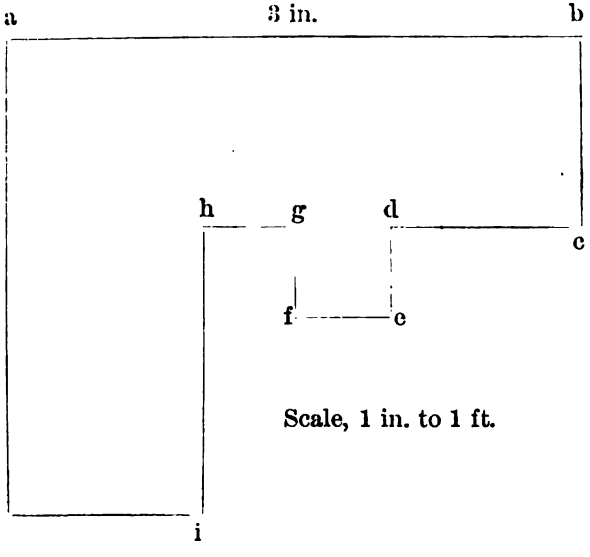
11. Is twice the distance from b to e greater or less than the distance from a to b? How much?

12. The distance around Fig. XXV. is equal to what part of the distance around Fig. XXIV.?

13. $\frac{3}{5}$ the distance around Fig. XXV. and $\frac{1}{1}\frac{1}{2}$ the distance around Fig. XXIV. is equal to what part of the distance around Fig. XXV.

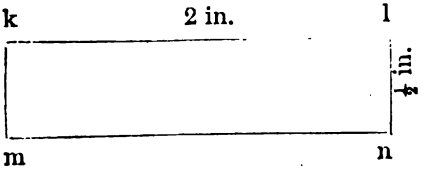
CHART XII.

FIG. XXIV.



Scale, 1 in. to 1 ft.

FIG. XXV.



14. How many $\frac{1}{2}$ feet in Fig. XXV.? How many less than in Fig. XXIV.?

15. One-half the distance from c to h is equal to what part of a b?

16. In the following questions, let 1 inch in Fig. XXIV. represent a mile instead of a foot. Then if a man started at b to travel to i, what part of the distance has he traveled when he gets to f?

17. Two men start at a. One goes to f, and the other $\frac{2}{3}$ as far. How many miles do they both travel? The first went how much farther than the second?

18. A road is built all around Fig. XXIV. excepting the side a j. What is the length of the road? How many miles were not built? What part of the whole distance was that?

19. Two men start in different directions from a to travel until they meet. Where will they meet?

LESSON II.

1. Mr. Miller built a book-shelf, using but one board. How *long* and wide was the board? (See Fig. XXVI.)

2. In the case he put books of different sizes. On the first shelf they were 4 inches thick. How many did he have on that shelf?

3. On the second shelf were books also 4 inches thick. How many had he?

4. The third shelf was filled with books 2 inches thick. How many were there?

5. The fourth shelf was full of books 1 inch thick. How many were on the fourth shelf?

6. What part of the books were on the first shelf? On first and second?

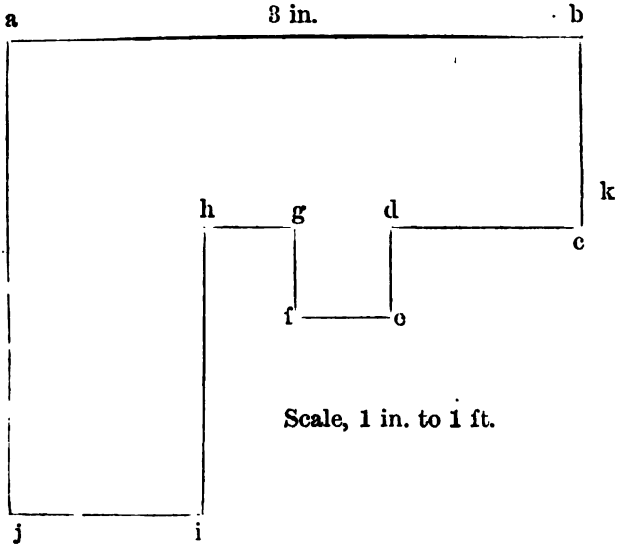
7. What part of the books were on the third shelf?

8. What part of the books were on the fourth shelf?

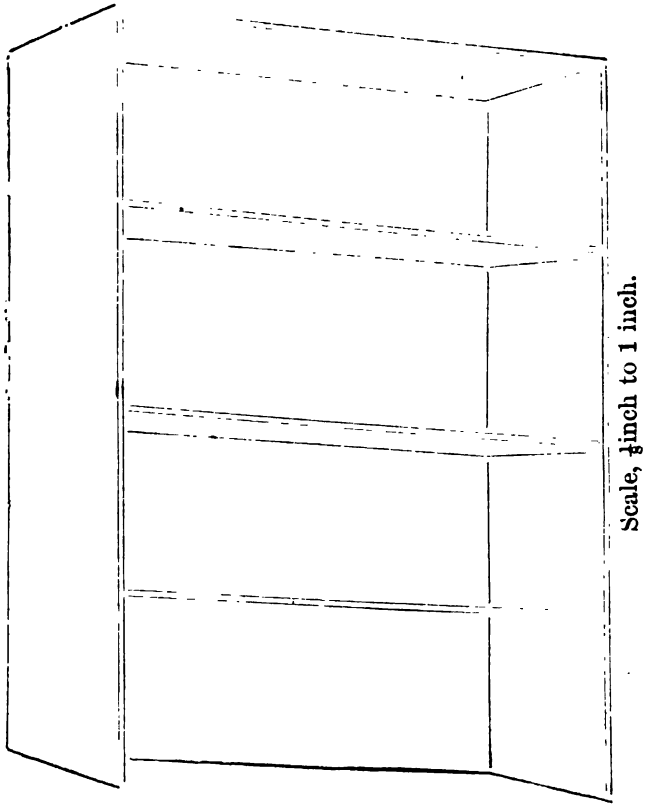
9. If the books had all been the size of shelf 4, how many would he have had? Shelf 3? Shelf 2?

CHART XII.

FIG. XXIV.



Scale, 1 in. to 1 ft.



Scale, ¼inch to 1 inch.

FIG. XXVI.

SUGGESTIVE QUESTIONS ON CHART XIII.

1. Figure XXVII. represents a township. In which states are there very irregular boundary lines? How did it happen that they are so irregular? If a man walks from A, following the boundary lines around the township, how many miles will he walk east?

2. How many miles will he walk west?

3. How many miles will he walk north? How many miles south?

4. If X wishes to go to R, how many miles will he save by going direct to R instead of following the boundary line?

5. How many 5 miles will he save?

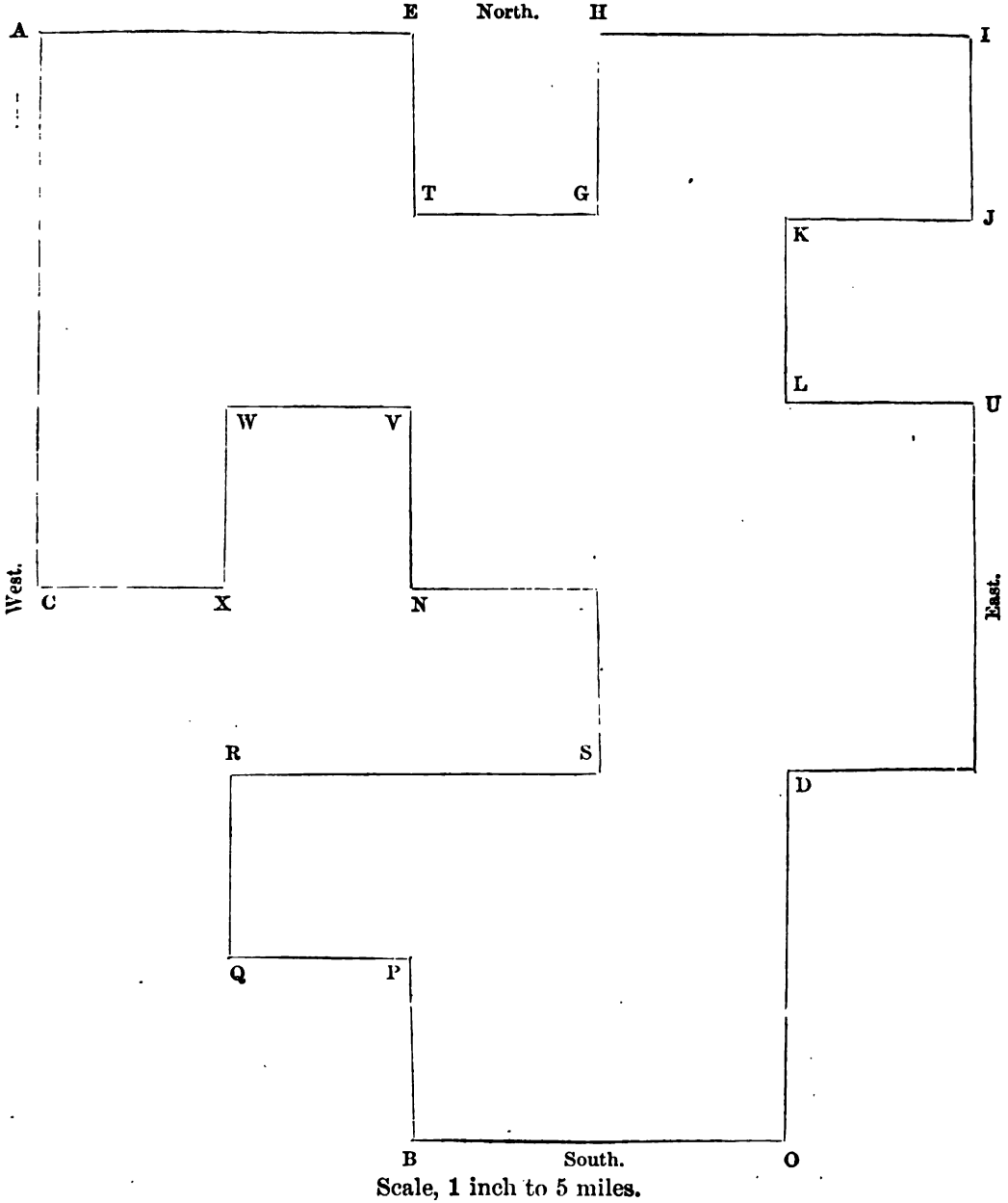
6. A starts for X *via* C. What part of his journey has he gone when he gets to C?

7. If 15 miles are $\frac{3}{4}$ of the distance, what is the whole distance?

8. If after he gets to X he then travels five times as far as he has already gone, how far will he be from home *via* the boundary line? Why but 40 miles?

9. How many 10 miles will he have traveled? How many 8 miles? How many 6 miles? How many 3 miles? How many 4 miles?

CHART XIII.



Scale, 1 inch to 5 miles.

FIG. XXVII.

SUGGESTIVE QUESTIONS ON CHART XIV.

LESSON I.

1. Fig. XXVIII. is the map of a farm. How many 16-foot boards must I buy to build a fence around lot N, making the fence 8 feet high, each board being 8 inches wide?

2. After the fence for lot N is built, how many boards must be used to build a fence around lot M?

3. How many posts must be used to fence in the farm if the posts are placed two to a rod?

4. If a man plows lot K, how many miles will he walk if he crosses the lot 32 times?

5. How many rods is it from the N.W. corner to the S.E. corner of lot N? (What is the scale?)

6. How many trees can be set out on the western boundary of lot L if placed 6 feet apart?

7. How many more can be placed on the eastern boundary line of lot K than on the western boundary of L?

LESSON II.

1. Fig. XXIX. is the map of another farm. How many rods of wire will it take to fence it three wires high?

2. How many boards 10 feet long, if they are placed 5 boards high, will it take to fence it?

3. How many posts if placed 5 feet apart?

4. If a fence is built from I to J, how many rods of wire will be used to build the fence 4 wires high?

CHART XIV.

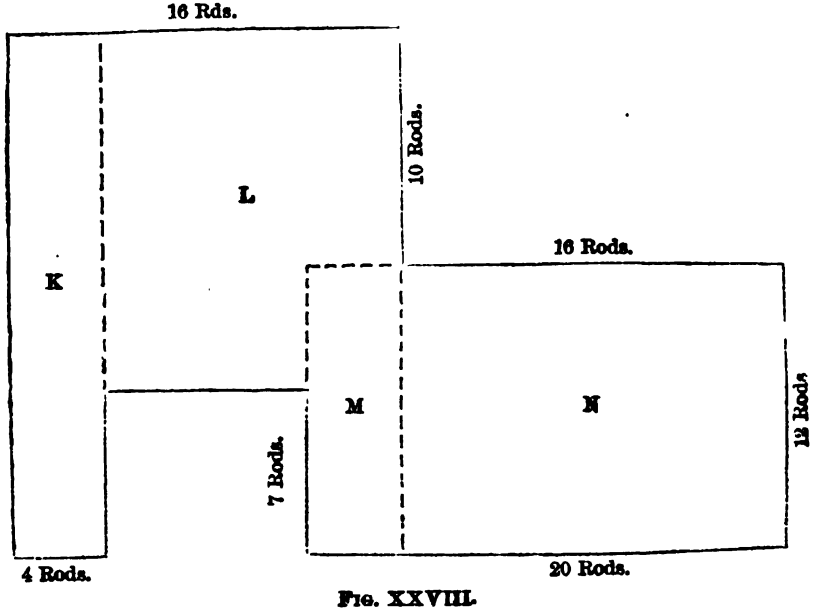


Fig. XXVIII.

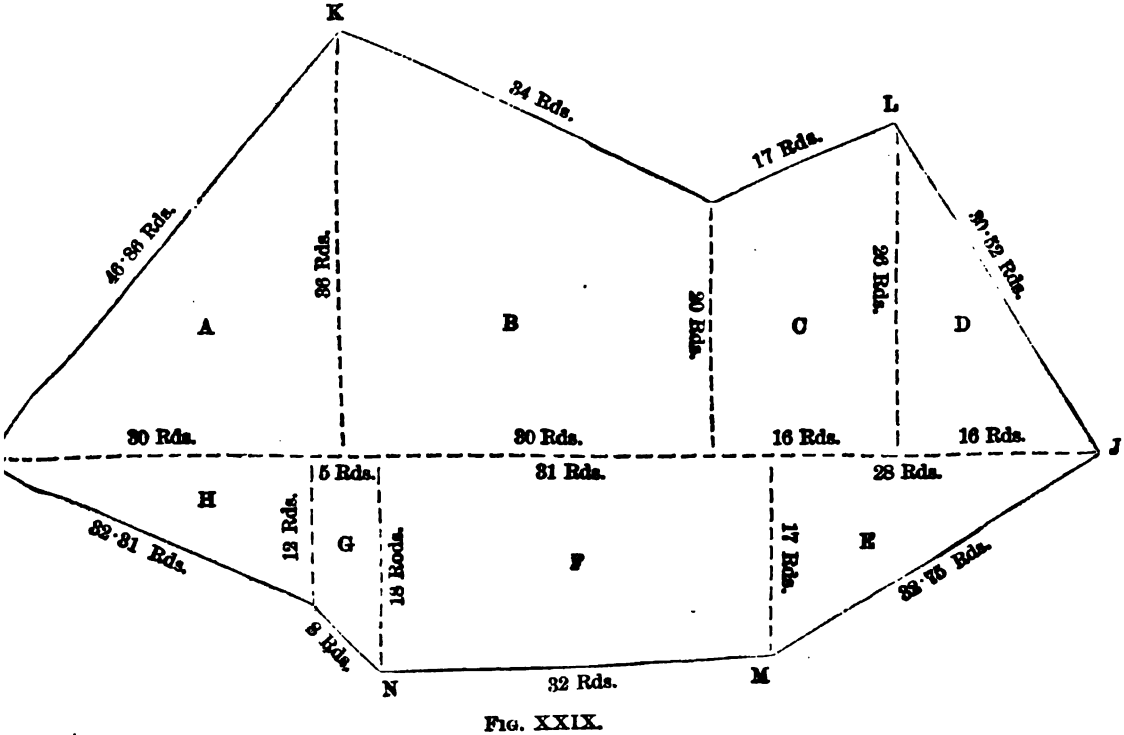


Fig. XXIX.

SUGGESTIVE QUESTIONS ON CHART XV.

LESSON I.

1. What is the sum of the distance around A, B and C?

2. Suppose A to be a garden plot, we will cut off a strawberry bed on the north by extending the line c f until it cuts line a e. What is the distance around the strawberry bed?

3. If the plants around the border are set 2 feet apart, how many plants must be bought?

4. Around the other bed in the plot we will set raspberry bushes 4 feet apart; how many bushes will there be?

5. Around which bed is it the farther? How much?

6. Suppose you take the fence away from B and start to fence C with it; how much of C will be left unfenced?

7. What is the difference between the distance from a to e and the distance from b to d?

8. How much would it cost to build a fence around A four boards high, if you used 8-ft. boards, and each board cost 15c.?

9. If you put the same sort of a fence around B also, how much would it cost altogether?

10. One man walks from a to i; another walks five times as far; how far do they both walk?

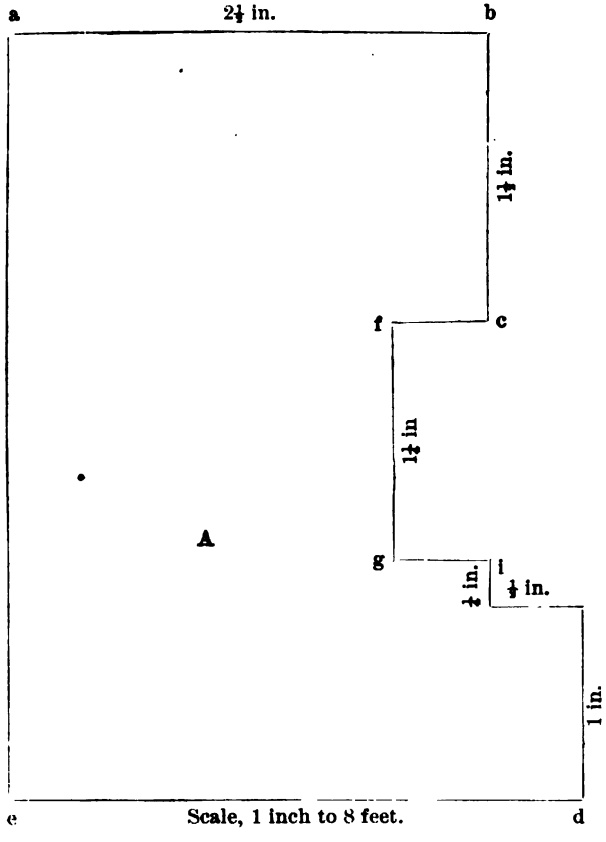
11. Which is the longer distance, three times around B, or four times around C? What is the difference?

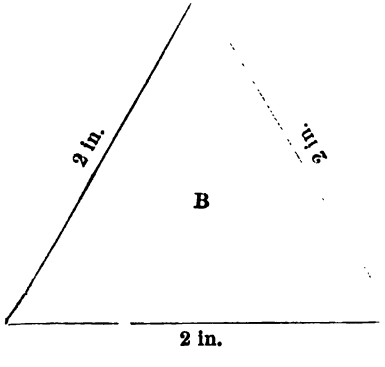
12. Four times i h is what part of the distance around A?

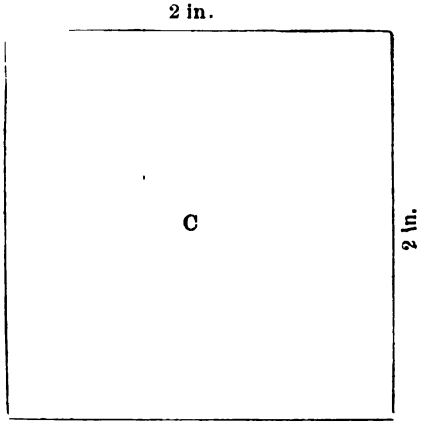
13. How many distances equal to one side of B are there in C?

14. How many such distances are there in A?

CHART XV.


a
2¼ in.
b
1½ in.
f
c
1½ in
A
g
¼ in.
i
¼ in.
1 in.
e
Scale, 1 inch to 8 feet.
d


2 in.
2 in.
B
2 in.


2 in.
C
2 in.

15. If a turtle crawls 2 ft. in a minute, how long will it take him to crawl around A?

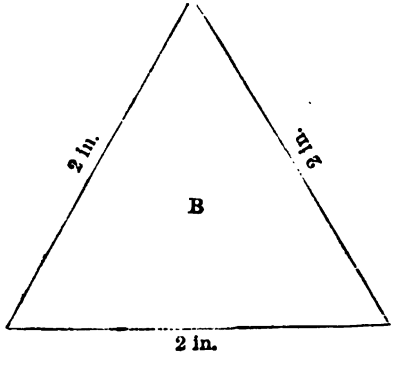
16. There is a trench to be dug around B, and another around C. The man digging around B digs 6 ft. in 1 hour; the man digging around C digs 4 ft. in half an hour; which will finish first? How much sooner?

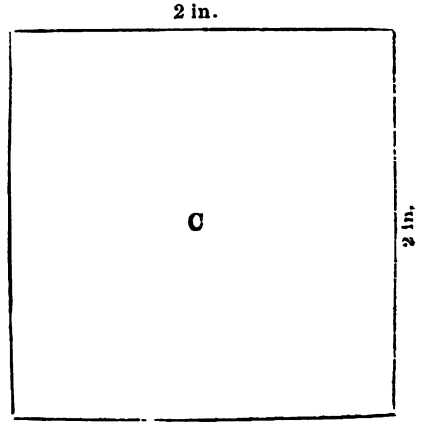
17. Two men start to travel toward each other; one walks as fast as the other; the starting points are b and d; how far will each walk before they meet?

18. What part of the distance will each walk?

19. If one walks twice as fast as the other, how far will each walk before they meet?

20. What part of the whole distance?





5. The owner of the farm began at I and walked around the farm. How many rods less than a mile did he walk?

6. What part of a mile is the distance N to M?

7. What part of a mile is the length of lot B's eastern boundary line?

8. What part of a mile is the western boundary line of lot G?

9. The southern boundary line of lot C is what part of a mile?

10. The southern boundary line of lot G is what part of a mile?

NOTE.—Questions in area may be given here also. Have the children write original questions on each lot, both in area and lines.

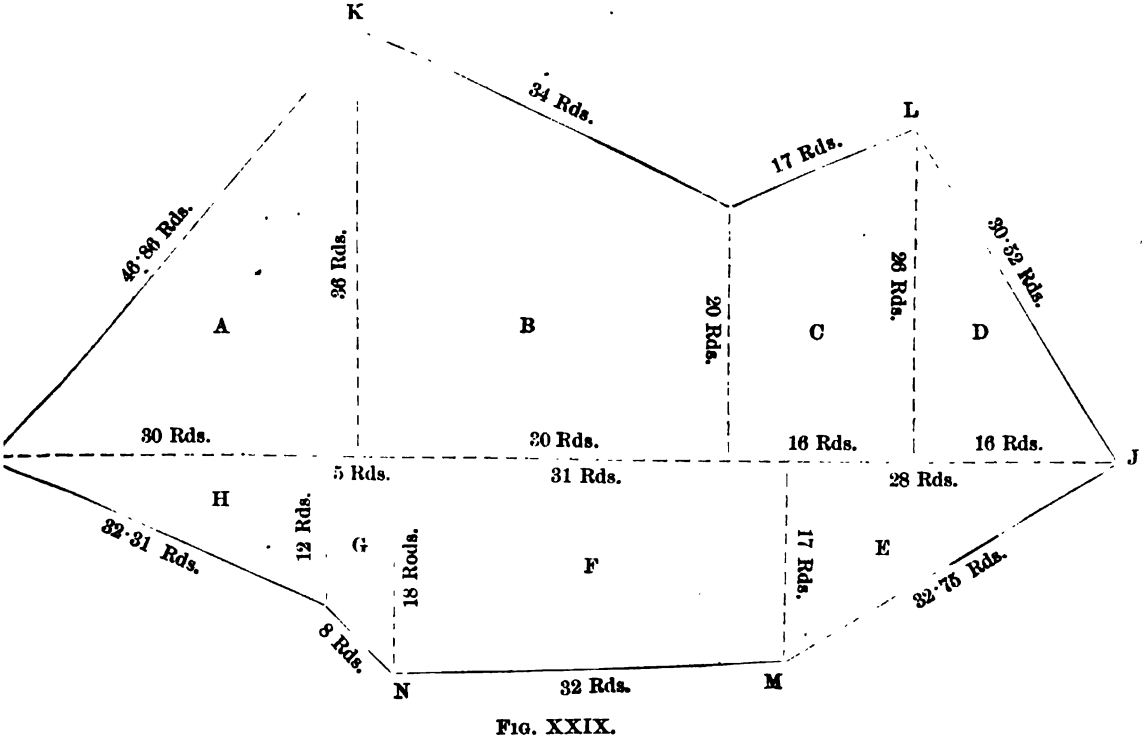


FIG. XXIX.

SUGGESTIVE QUESTIONS ON CHART XVI.

LESSON I.

1. What do we call figure 30?
2. What do we call the curved line which bounds the circle?
3. What do call A B?
4. What do we call O C? O C and O D?
5. What other line equals A B? Why?
6. What do you know about all the diameters of any circle?
7. What part of the circle is A O C?
8. What kind of an angle is A O C?
9. How many halves in every circle?
10. Upon what does the size of the halves depend?
11. How many degrees in every circle. Why was 360° used?
12. Upon what does the length of a degree depend?
13. If the circumference of a circle was 360 inches, what would be the length of one degree?
14. If the circumference of a circle was 720 inches, what would be the length of one degree? If the circumference was 1800 inches? If 3600 inches? If 2880 feet?

LESSON II.

1. The circumference of the earth is 25,000 miles. What is the length of a degree on the earth?
2. What kind of an angle is A O C? How many degrees does a right angle equal?
3. How many degrees in the angle C O D? What do we call such an angle?

CHART XVI.

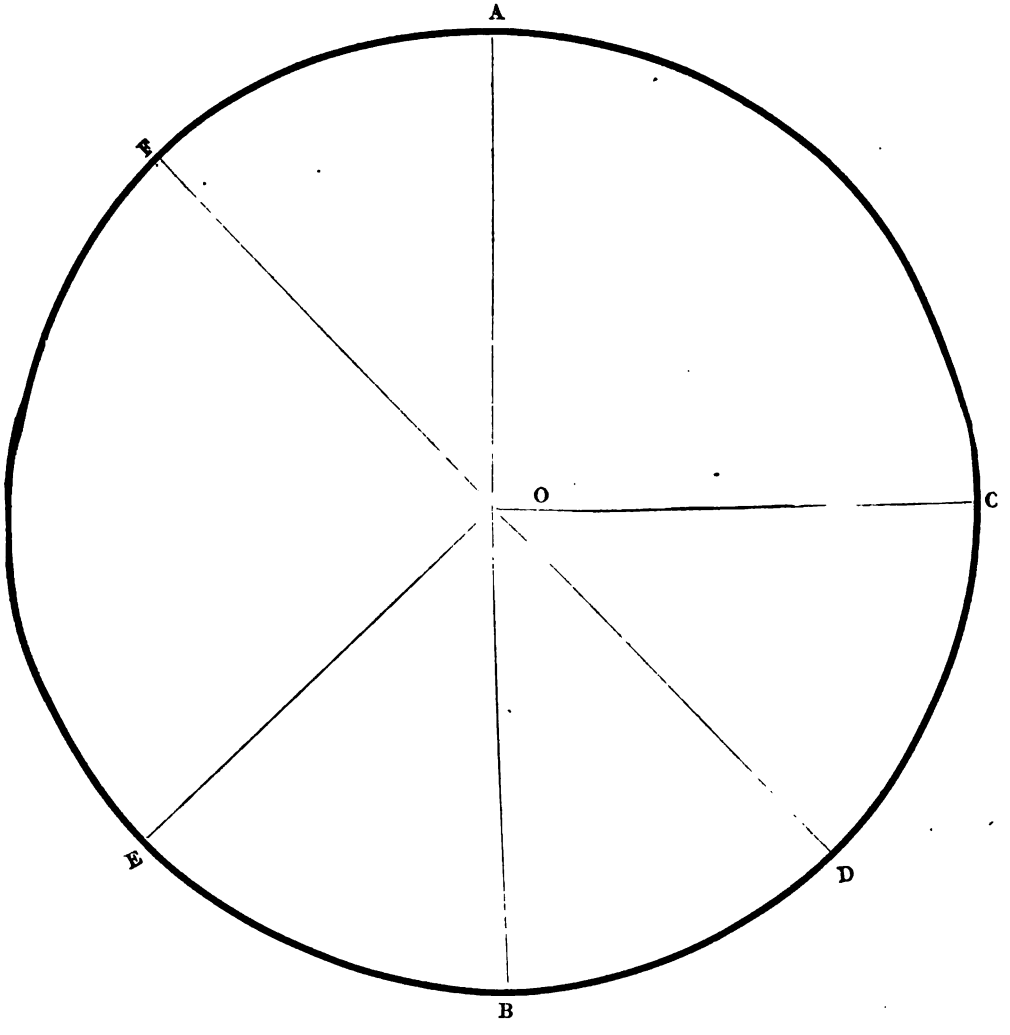


FIG. XXX.

4. How many degrees in the angle C O E? What do we call such an angle?

5. What kind of an angle is F O E? How do you know it is?

6. If the circumference of Fig. XXX. were 22 inches, what would be the length of one degree?

7. How far then from C to A *via* the circumference?

8. How far from D to C? B to A?

9. If we know the diameter of a circle we can find the circumference by multiplying the diameter by $3\frac{1}{7}$. (This is true for all practical purposes.) What is the circumference of a circle whose diameter is 7 inches? 14 inches? 21 inches? 28 inches? 35 feet? 49 feet?

10. If the diameter of a circle is 9 feet, what is the circumference?

MISCELLANEOUS PROBLEMS.

1. John had a toy railroad 1 yard long. How many feet of rail did he use to make the road?

2. If it takes 3 feet of picture wire to hang one picture, how many yards will it take to hang three pictures?

3. A box is 2 inches square; how long must a string be to pass around it?

4. Henry is 3 feet 6 inches tall, and John is 4 feet 8 inches. How much taller is John than Henry?

NOTE.—Measure the children in your class, and thus obtain very interesting problems. At the end of the term measure them again. More interesting problems are thus obtained.

5. May and Jennie had a little twig which they were observing together. On the first of April it was one foot high. On the first of May it was one and ½ foot high. How many inches did it grow during April?

NOTE.—If the teacher will plant some kernels of corn, a few sunflower seeds, or a morning glory in boxes, tin cans, etc., she will be able to give many problems during the year, making a point to notice when the plant or vine is just one foot, yard, rod or chain in length. A cheap sponge placed in a water-tight dish, kept partly filled with water, and covered with oats or bird-seed, will also prove very interesting to the children. Measurements may be taken almost daily, the growth is so rapid. Thus the science lessons enhance the number work.

6. A floor is 13 feet square. How many yards of carpet will it take for a border in this room?

7. From the floor to the ceiling it is 15 feet. The plumber desires to put in a fixture that shall be 6 feet 4 inches from the floor. How long a gas-pipe must he use?

8. I have a set of books; twenty-one in all. Each book is 3 inches thick. I desire to put them on 3 shelves. How long must I make the shelves?

9. Mary has a flower bed 4 feet long and 3 feet wide. She wishes to set out three rows of plants; the plants to be six inches apart. How many plants must she buy?

NOTE.—Draw a plan of the bed, using a scale of 1 inch to a foot. Place the plants in proper position.

10. A teacher had some strips of board, three in all, placed in the dressing-room. On these strips, which were three feet long, she wished to put hat hooks 4 inches apart. How many hooks did she buy?

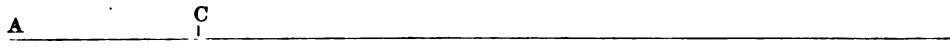
11. I have a box which is eight inches long and two-thirds of a foot wide. How many inches are there one-half way around the box?

12. I wish to carpet my stairs, and I buy a piece of carpet 16 yds. long; it takes one-half yd. for each step, and there are twenty-six steps. How many yards will I have left?

13. A wire fence is 8 ft. long. I wish to extend it $2\frac{2}{3}$ yds. How many feet of fencing must I buy? How long will the fence be when finished?

14. A two-cent piece measures 1 in. in diameter. How many two-cent pieces can I place on a ruler which measures $1\frac{1}{3}$ ft.?

15. A field is divided into 4 square lots, each lot being $\frac{1}{2}$-mile square. I walk 4 times around the field. How many miles do I walk?



16. From A to C it is 2 miles which is $\frac{1}{5}$ of the distance from A to B. How far is it from A to B?

17. Henry drives from B to A and then from A to C; how far does he drive?

18. John lives at A. His school is at C. How far does he walk in going to and from school?

19. William walks from B to C. How much does he lack of walking 10 miles?

20. For ten days, Thomas rides his bicycle to and from school, *i. e.*, from A to C, coming home to dinner each day. How many miles does he ride?

21. Jennie walks $\frac{1}{2}$ of A B miles. How many miles is that? $\frac{1}{2}$ of A C? $\frac{1}{2}$ of C B? A B and $\frac{1}{2}$ of A C? A C and $\frac{1}{2}$ of A B?

A B C

22. From A to B it is 6 yards, which is $\frac{2}{3}$ the length of A C. How many *feet* long is A C?

23. B C is how many inches long? How many feet? How many yards?

24. Emma stood at B and threw an acorn to the point C, and then threw another to the point A. How many feet were the acorns apart?

25. John threw a stone from B to A and then threw another $\frac{1}{2}$ way to A. How many feet were the two stones apart?

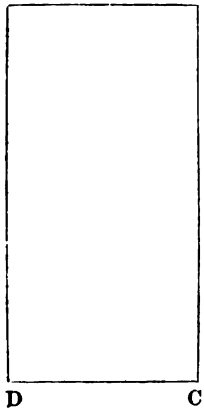
26. B C is what part of A C? What part of A B is it?

27. How many thirds in A B? How many thirds in B C? How many thirds in A C? George ran from B to C and back three times. How many feet did he run?

28. I have a string measuring 16 inches with which I wish to form a square. What will one side of the square measure?

29. A lady lives $1\frac{1}{3}$ miles from the city, she drives in every week-day morning and back every night. The number of miles she rides in 3 days is what part of the number of miles she rides each week?

30. James makes a frame for a lady, which is 16 inches long; when she tries to use it, she finds it is one one-sixteenth too long. How many inches too long is it?



31. A B is 1 rod long. How many feet is it from A to C *via* B?

32. How many rods of wire would it take to go around the lot once? How many chains?

33. What part of the wire would it take to go from C to D? From B to C?

34. What part of the wire would it take to fence the two longer sides, one wire high?

35. What part of the wire would it take to fence the two shorter sides, one wire high?

36. What part to fence the two longer and one shorter sides? What for the two shorter and one longer?

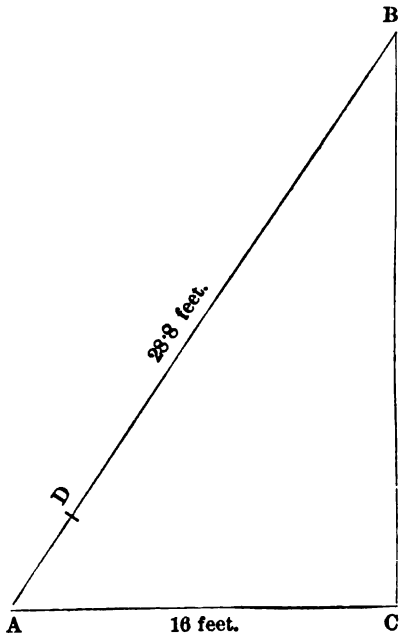
37. From the front gate, which is straight in front of my house, to the house is $4\frac{1}{3}$ yards; the house is 40 feet long, and from the house to the back gate, which is directly behind it is $8\frac{2}{3}$ yards. How many feet long is the lot?

38. John lives 51 yards north of the school. If he went for James who lives 13 yards south of the school and then went to school, how many yards did he walk? How many rods?

39. In a garden, a space a rod long and 16 feet wide is to be bordered with currant-bushes set 5 feet apart. How many bushes are needed?

40. How many rods make a mile? How does this compare with an English mile?

41. If one stratum of rock is 20 inches deep, another is 30 inches deep, and another 35 inches deep, what is the depth in feet of the three layers?



42. The depth of 2 strata of rock is 85 inches, one of them is 6 feet deep, what is the depth of the other?

43. A room is 25 feet long and 16 feet wide. In papering it, how many yards of border will be required?

44. I bought 85 feet of table linen, and made it up into 17 equal tablecloths. How many yards in a tablecloth?

45. How many feet in 24 yards and 24 feet?

46. A telegraph wire was strung from A to B, then from B to C, then from C to A. How many feet long was the wire?

47. John walked from B to C then

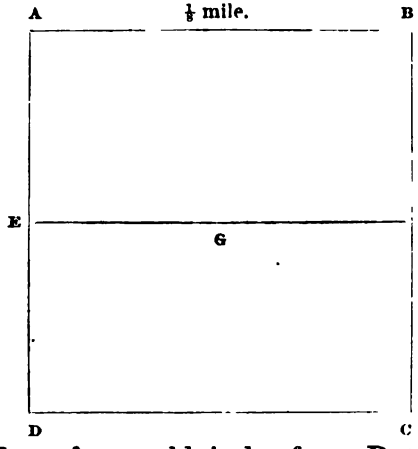
to A. William walked directly from B to A. Which boy walked the greatest number of feet? How many more feet did he walk?

48. How many feet is it from A to D? From D to C by way of B? From D to C *via* A?

49. If I go from A to B *via* C, how much farther do I walk than when I go from A direct to B?

50. A C is equal to what part of B C? How much greater is B C than B D?

51. How many A D's in A C? In B C? In A B?

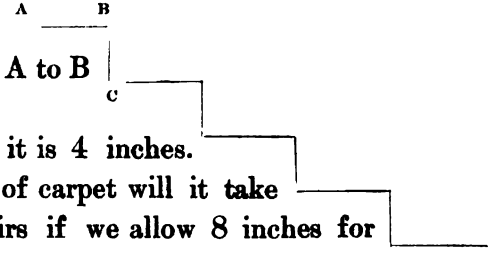


52. How many rods of fence-wire will be required to build a fence around A B C D three wires high?

53. How many ten-foot boards must be used to build a fence 5 boards high?

54. How many 8-foot boards will it take to build a fence 5 boards high, from E to F, if an opening is left at G, twenty feet wide?

55. If A B equaled 27 inches; how far would it be from B to D the shortest distance? (N. B. Here the scale is $\frac{1}{16}$ inch to 1 inch, A B equals 27 sixteenths. Find how many sixteenths B D equals. Each sixteenth representing one inch.)

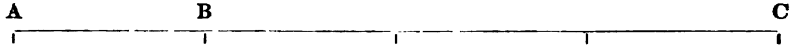


56. From A to B it is 6 inches.

From B to C it is 4 inches. How many yards of carpet will it take to carpet the stairs if we allow 8 inches for turning under?

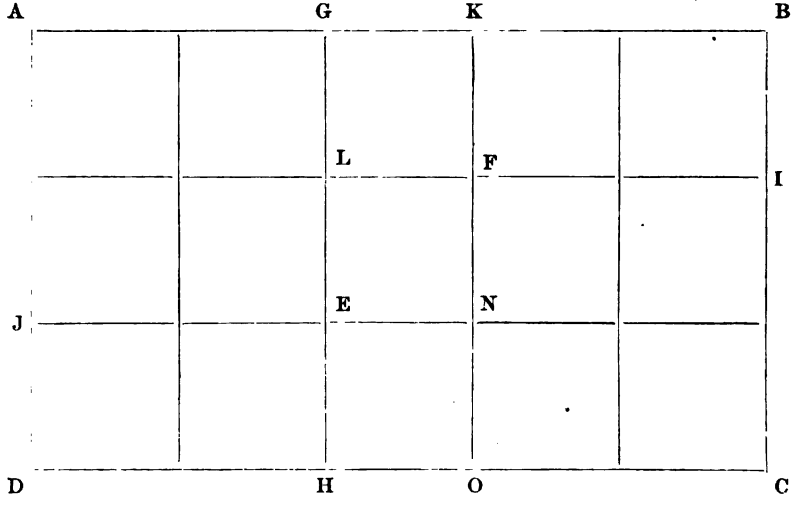
57. A stairs contains 12 steps, each step being 12 inches wide and having a raise of 6 inches. What will it cost to carpet the stairs at 75 cents per yard?

58. From A to B it is $\frac{1}{2}$ foot, from B to C $\frac{1}{3}$ foot. How many yards of carpet will it take to carpet the stairs if we allow $\frac{2}{3}$ feet, for turning under?



59. From A to B it is 66 *feet*. How many *rods* from A to C? How many chains?

NOTE.—We have here given an excellent exercise, as it may be adapted to any grade in the primary, grammar, or first high school year.



60. From A to B it is 5 feet. How far is it from G to K? From B to C? From B to O? From A to B it is $2\frac{1}{2}$ miles, how far is it from J to D? From G to H? How far from A to D *via* B and C?

61. From A to B it is $7\frac{1}{2}$ miles. How far is it from K to F, to L, to G, back to K?

62. A B equals 200 rods. How far does a man walk, *i. e.*, how many miles, who goes from B to D *via* C?

63. A G is what part of the distance A B? Of A K?

64. If John starts from A to go around A, B, C, D, what part of his journey has he gone when he arrives at H?

65. If we were to cut off the top row of squares, how many thirds of the whole would that be? How many fifteenths? $\frac{1}{3}$ equals how many

fifteenths? If we cut off the right hand row, what part of all do we take? How many fifteenths? $\frac{1}{5}$ equals how many fifteenths?

66. A B equals 80 chains. William rides on his bicycle from A to H *via* D. How many miles does he ride?

67. John rides his bicycle from A to O *via* B and C. How many miles does he ride?

68. G K equals 33 feet. How many times must John ride around A B C D to ride a mile?

69. How many times must William ride around G K O H to ride a mile, if G K equals one-half chain?

70. B C equals 1 chain. What part of a mile does a man walk who goes from C to B by way of C D A K F I?

71. How many times must Henry ride around A B C D to make a mile, when B C equals 1 chain?

72. A B equals 1 chain. How many feet around A B C D?

73. If I travel from A to C and then from C to B, *via* D, I travel 96 miles, but if I go direct to B, I travel 72 miles. How many miles is it from D to C? Why 12 miles?

74. What part of A B equals C D? C D equals what part of D B, if A D equals 48 miles?

75. How far is it from A C, the shortest direction, or C A? (N. B.—Measure A B and find the scale. Next measure A C and obtain the answer.)

76. How far is it from C to B by the air line?

77. The tire of a wheel measures one foot in circumference. How many revolutions would the wheel make in going 8 yards? Ans.

78. If in every mile there are 8 blocks, what will be the name of

the street 6 blocks south of a station which is 10 miles from "First Street," all the streets being named according to their number? —— street.

79. How many yards of border will be required to place around a parlor which is 12 ft. by 14 ft., and a sitting-room which is 12 ft. by 16 ft.? —— yds.

80. Forty-eight badges were made out of 12 yds. of ribbon. What part of a yard was used in each badge?

81. A laundress washes 5 sheets, each 2 yards wide. How many feet of her clothes-line will these occupy if no space be allowed between?

82. If it takes three feet of binding twine for every sheaf of oats, how many yards of twine will bind 45 sheaves that were missed by the machine?

83. There are 6 straps on each side of the street car. In each strap there are 2 feet of leather. How many cars can be supplied with straps out of 16 yards of leather?

84. I have $9\frac{2}{3}$ yds. of clothes-line. I wish to put it up lengthwise in a room 25 feet long. How much will I have left to tie with?

85. How many yards of border will it take for a room 10 ft. long and 8 ft. wide? Ans.

86. If there were 3 windows in the same room which reach to the ceiling, and each window was 3 ft. wide, how many yards would it take? Ans.

87. There are six columns on our portico having the form of an equilateral hexagon. How many feet in the perimeter of the six columns if each side of the hexagon is 6 inches? Ans.

88. Our table is 14 ft. long and 4 ft. wide. How many guests can I seat at it if I allow 24 inches for each person along the side and two persons at each end?

89. One side of a square block is 6 inches long; how many inches around the block?

90. James's home is 2 rods from Henry's; how many yards of wire will be needed to make a telegraph from James's window to Henry's?

91. I have a square flower-bed 8 feet on each side. How many yards of wire will be required to put a fence around it 3 wires high?

92. The center aisle of a church is 86 feet long. Floor matting 6 feet wide cross this aisle at both ends. How many feet will be required to lay a strip down this aisle?

93. How many foot rulers can be made out of a stick a rod and 6 inches long?

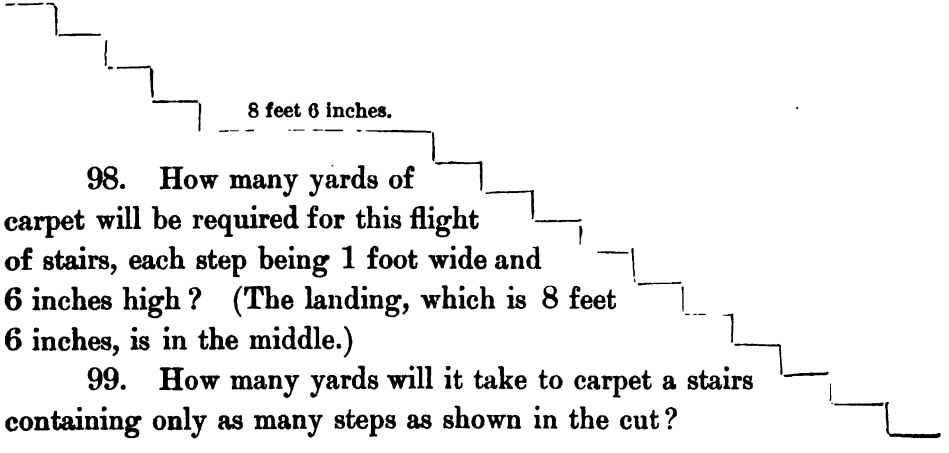
94. What part of 2 miles would a man travel in going around a field one-quarter of a mile square?

95. Goods are carried up to the window of a store in small wagons. The track over which the wagons run is $9\frac{1}{2}$ yards long; how many feet of rails were required to build it?

96. The black-board in our school-room is 57 feet long. It is divided into sections 18 inches wide; how many sections are there?

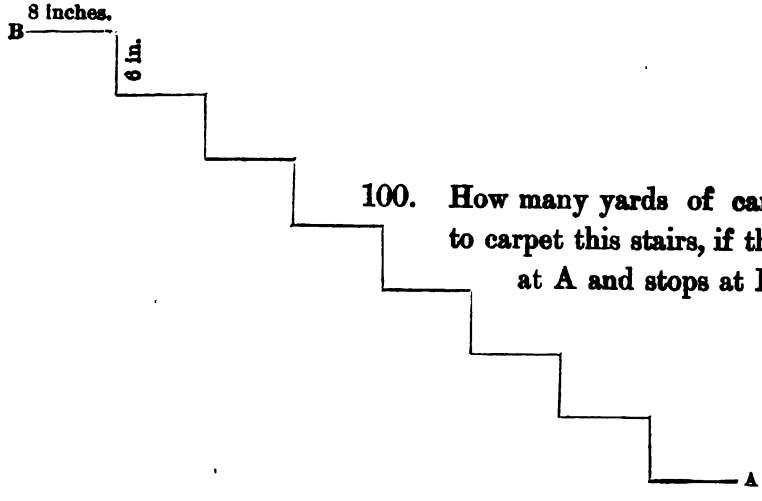
97. A barber pole, which is $4\frac{3}{4}$ feet high, is painted in bands of equal width. There are 6 bands; how many inches wide is each band?

Scale, $\frac{1}{4}$ inch to the foot.



98. How many yards of carpet will be required for this flight of stairs, each step being 1 foot wide and 6 inches high? (The landing, which is 8 feet 6 inches, is in the middle.)

99. How many yards will it take to carpet a stairs containing only as many steps as shown in the cut?



100. How many yards of carpet will it take to carpet this stairs, if the carpet begins at A and stops at B?

HOME WORK.

101. Open your geographies at the map of North America. What is the scale used?

102. Find how long North America is from north to south.

103. Find how long North America is from east to west.

104. Open your books at the map of South America. What is the scale used here?

105. Find how long South America is from north to south.

106. Find how long South America is from east to west.

107. Which is longer from north to south, North America or South America? How much?

108. How long is the Mississippi river?

109. Find the length of the Amazon river?

110. Which is longer, the Mississippi or the Amazon? How much?

NOTE.—Like questions may be given on all the continents. It will prove interesting to note the accuracy with which the children do this work.

111. At 8:30 A. M. take a stick 3 feet 4 inches long. Drive it into the ground 4 inches. How long is the shadow cast by this stick? Measure the same shadow at 12 o'clock. Is it longer, or shorter? How much? Why this difference?

112. Will the shadow grow longer or shorter in the afternoon? Why?

113. Will the shadow be the same length every day in the year at 12 o'clock? Why?

114. At what time of day will the stick cast the longest shadow? Why?

115. Is there any place on the earth where the stick would cast no shadow at noon? Why?

116. A man walked $15\frac{2}{3}$ yards and then returned 4 feet. If he had gone 5 feet further before returning, how many feet would he have traveled?

117. Clara and Maud were going to make a play telephone between their two houses, which were 61 feet apart. They found that the piece of string they had was only 3 rods long. How many more yards did they require in order that the string reach from one house to the other?

118. It requires 10 yds. 6 in. to curtain one window with lace. How many yards will 6 windows require?

119. If it requires 5 feet 1 inch of ribbon to bind a table scarf, how many scarfs can I bind with 61 inches of ribbon?

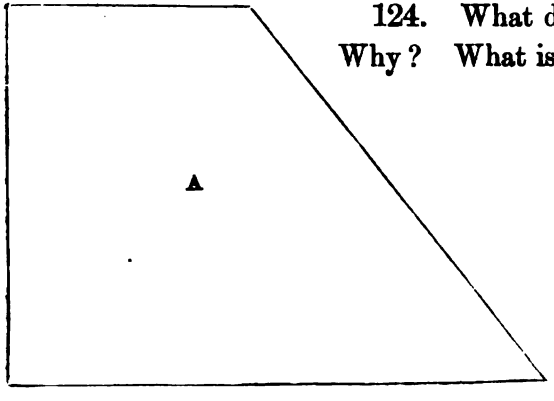
120. One boy can walk 61 feet in 15 seconds. Another can walk one-sixth as fast. How many yards can the second one travel while the first is walking the 61 feet?

121. How many times will a wheel, 12 feet 6 inches in circumference, turn round in rolling one mile?

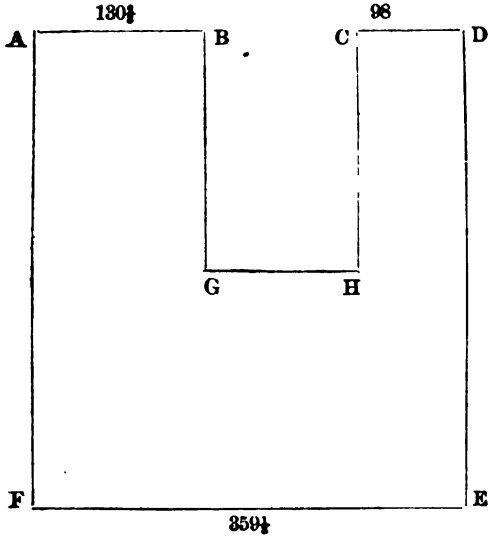
122. A wheel is 7 feet in diameter; how many times must it turn round in rolling 40 chains?

123. I have a square lot at each corner of which I dig a post hole. Then beginning at the northwest corner, I dig on the north side six post holes, 8 feet apart the last hole being four feet from the corner. Beginning at the same point again I dig, as before, the same number of holes on the west side. Next, I begin at the N.E. corner and dig the same number of holes the same distance apart, on the E. side. On these three sides of the lot, I build a fence, 12 boards high, using 8-foot boards. On the west side of the lot, beginning at the N.W. corner I build three pens. The north and south sides of each pen are 16 feet long and the east and west end, of each, are 8 feet wide. The pens are 8 feet apart and the S. half of each E. end is left open. On the E. side of the lot, I build 3 pens

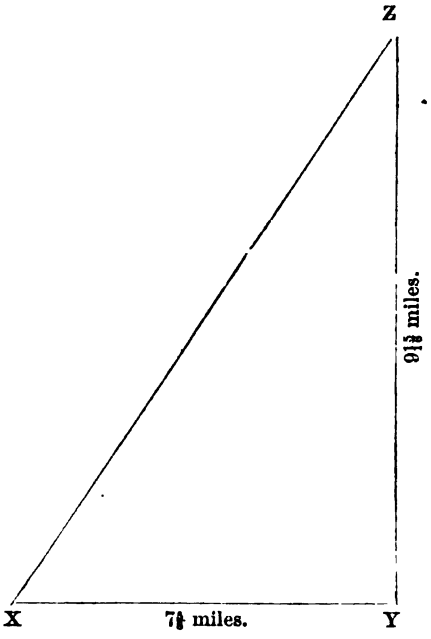
the same as the others, with this difference: the N. and S. sides are 12 feet long, and the S. half of the west end of each is left open. The sides and ends of the pens, *not including the fence* sides, are to be 4 boards high. (1) How many boards will it take to build the fence and pens? (2) What will the required number of posts cost at 25c. each?



124. What do we call such a figure as A? Why? What is its perimeter?



125. If, as shown in the cut, it is 359⅓ miles from F to E, how far must it be from G to H? Find the answer without measuring G H.



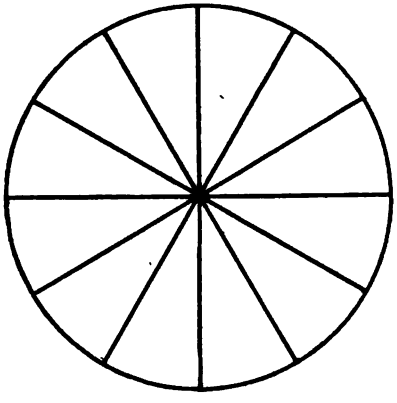
126. If X Y represents $7\frac{5}{8}$ miles, and Y Z represents $9\frac{5}{16}$ miles, how far must it be from X to Z direct? Find the answer by measuring, and prove by square root.

127. The distance between the house and the shed is $33\frac{1}{3}$ feet. How many yards of clothes-line will be needed to stretch twice across the yard from the house to the shed?—$22\frac{2}{3}$ yards.

NOTE.—It adds very much to the following problem if the pupils are requested to bring in a plan showing the route taken by each man. Have it drawn to a scale of $\frac{1}{8}$ or $\frac{1}{16}$ inch to the mile. The higher grades can prove their work by finding the length of the hypotenuse by square root. By using smaller numbers the same problem may be given to the lower grades.

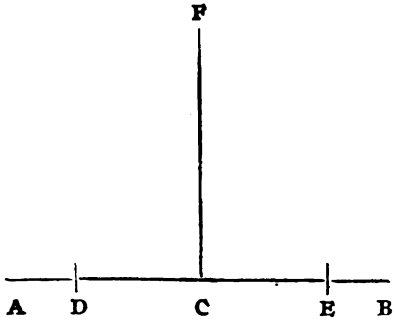
128. Three men, A, B and C, start from the same place at 7 A. M. and walk on an average one mile in fifteen minutes. B goes directly north from the starting point and walks until 3 P. M., when he rests for an hour, after which he continues to walk until 11 P. M., when he arrives at his destination. C goes directly east from the starting point and walks until 12 M., when he rests until 6 P. M. At 6 P. M. he begins walking again, and walks until 11 P. M. A goes directly west from the starting point and walks until 1 P. M., when he rests for $3\frac{1}{2}$ hours, when he again begins to walk and continues until 11 P. M. The next morning B takes a road directly southeast to C's. When he arrives at C's he finds that C

has gone to A's. Hoping to find C at A's, B goes directly west from C's to A's, but when he arrives at A's he finds that C and A have gone to B's. B then goes directly northeast from A to his own destination, where he finds A and C waiting for him. How many miles did B travel altogether?



129. What is the circumference of this circle? How is it divided? How many $\frac{1}{4}$ in $\frac{2}{12}$? How many $\frac{1}{12}$ in $\frac{1}{4}$? How many in $\frac{1}{2}$? $\frac{1}{2}$ of $\frac{1}{2}$ equals how many twelfths? $\frac{1}{6}$ of $\frac{1}{2} = ?$ $\frac{1}{3}$ of $1 = ?$

NOTE.—When two lines are perpendicular to each other, they form a right angle. To erect one line perpendicular to another at any point as C on the line A B. Use C as a center and with any radius, cut A B at D and E. With D as a center and a greater radius than C E describe an arc at F. With E as a center, and the same radius describe an arc intersecting the other arc at F Draw C F which is perpendicular to A B. When no compasses are to be had, use a card board or paper having a square corner, placing one edge so that every point will meet every point on the given line. Draw the perpendicular along the other edge.



GOOD TESTS FOR CAREFUL PUPILS.

NOTE.—In the work here given, care must be taken that everything is done accurately, or bad mistakes will follow. Careless children will seldom, if ever, get correct answers to the problems. Here, as in sloyd work, every part must be made to fit, or the whole plan will be wrong.

1. Andrew Williams owned a lot which was described as follows: Beginning at the northwest corner, the boundary line point A ran east 40 rods to a point B. From B south 16 rods to a point C. From C west 24 rods to a point D. From D northwest to the place of beginning. How many rods from A to D?

2. How many boards 1 foot wide and 16 feet long will it take to fence the lot if the fence is $\frac{1}{2}$ board high? (Scale, $\frac{1}{8}$ inch to 1 rod.)

3. My lot is bounded as follows: Beginning at the N.W. corner which we may call A, the northern boundary runs east 48 rods to a point B. From B south 20 rods to a point C. From C the line runs northwest in direct line for A 12 rods to a point D. At D it turns, forming a right angle with D C, and extends southwest 8 rods to a point E. At E it turns northwest, again forming a right angle, this time with D E, and extends 17 rods to a point F. From F it extends northwest to A, the point of beginning. How long is A F? (Scale, $\frac{1}{8}$ inch to 1 rod.)

4. I build a picket fence on the north side, using pickets 4 inches wide, and placing them 2 inches apart. How many pickets are required?

5. Here is an odd-shaped lot. From the northwest corner A, the boundary line runs 32 rods (scale, $\frac{1}{8}$ inch to 2 rods) east to a point B, then south 32 rods to a point C, then west 32 rods to a point D, then

south 32 rods to a point E, then west 20 rods to a point F, then northeast from F to the point of beginning. How long is A F?

6. How many rods around a lot whose boundary lines are described as beginning at a point A and running east 32 rods to a point B. From point B to the southeast to a point C, which is 12 rods east of a point 12 rods directly south of B. From point C west 12 rods to a point D. From D south 8 rods to a point E. From E to a point F 16 rods from E, and in direct line for point A. From F 8 rods southwest to a point G, forming a right angle with F E. From point G northwest to the place of beginning.

7. Mr. Smith starts at a point A and walks around an irregular piece of land, where he is to build a five barb wire fence. He walks directly east 32 rods to a point B (Scale, $\frac{1}{8}$ inch to 2 rods). From point B south 48 rods to a point C. From C, in the direction of a point D (an oak tree) which is A B extended west 32 rods, 16 rods to a point E. From point E south 24 rods to a point F. From F in a northwesterly direction 40 rods toward point A to a point G. From G at right angles with F G southwest 36 rods to a point H. From point H northeast to the place of beginning. (1) How many chains did Mr. Smith walk? (2) What would the wire for the fence cost at 7 cents a pound, allowing 33 feet to a pound?

8. Mr. White owned a rectangular piece of land whose north and south sides were each 32 rods long, and whose east and west sides were each 24 rods long. Two railroads cut off portions of it. One took all west of a line beginning at the northwest corner and running southeast to a point 16 rods west of the southwest corner. The other took all east of a line beginning at a point 12 rods south of the northeast corner and running southwest to a point 8 rods west of the southeast corner. Mr. White then sold one road a N.E. corner lot facing the east, having a front of 198 feet and being 132 feet deep. Draw a map of the land to show the shape of the lot Mr. White had left.

9. In a lot was a race track. Every point of the longer boundary-line of which was 11 rods from the center of the lot and every point of

the shorter boundary was 10 rods from the center. What was the length of each boundary line?

10. I have a lot that is called the "flatiron" lot, each side of which is 32 rods long. Draw a map of the lot using a scale of 1 inch to 8 rods. Another lot was bounded as follows: From A south to B the line was 40 feet long. From B west to C 30 feet. It then ran northeast to place of beginning. How many pickets, 4 inches wide and placed 2 inches apart, must I buy for a fence?

11. Mr. A's garden boundaries may be described as follows: Beginning at the northwest corner at a point A the fence extends directly eastward to a point B, a distance of 24 rods, then extending in a southeasterly direction 8 rods east of point C, which is 16 rods directly south of B, to point D. Then turning in a southwesterly direction at right angles with B D for a distance of 12 rods to point E, then due west for 16 rods to a point F, then northwest to the place of beginning. How long is A F? What is the distance around the garden?

12. Draw a plan of your garden, on a scale of $\frac{1}{8}$ inch to one rod, by placing a point A near the upper right-hand corner of your paper, from here draw a line 24 rods west to point B. From point B draw a line south 32 rods to point C. Place a point E 16 rods south of point A. Place a point D, 8 rods west of point E.; connect C and D. How far is it from C to D?

13. A man has a lot which he wishes to enclose by a wire fence using one wire. Beginning at a point A at the northwest corner, the boundary line extends east 16 rods; thence directly south 16 rods; thence directly west 16 rods. From A it runs southwest to a point 24 rods directly west of a point in the center of the eastern boundary; thence southwest to the western end of the southern side. How many rods of wire will it take to inclose the lot?

14. What will it cost to fence the north side of my lot, 6 boards high, with boards 16 feet long, and 4 inches wide at 10 cts. per board? The boundary line of the lot began at point A (the northeast corner) and extended south 16 rods to a tree (point B). From the point B directly

west 24 rods to a stump (point C). From C northeast in direct line with point A 12 rods to point D. From D directly west 12 rods to point E. From E directly north 9 rods to point F. From F to A the place of beginning.

15. My land may be shown by the following plan, on a scale of $\frac{1}{8}$ inch to one rod. Beginning near the northwest corner of your paper at a point A, draw a line 24 rods to a point B. Making a right angle at B, place a dot 16 rods south from B. From this dot directly east 8 rods, make a dot marked C. Connect B and C. From C directly west draw a line 16 rods to a point D. Connect D A. How many rods of wire will it take to fence it four wires high?

16. (Scale $\frac{1}{8}$ inch to 1 rod). From a point A, draw a line 24 rods west to a point B. From A draw a line south 8 rods to C. From B draw a line southwest 25 rods to a point D, where a line drawn west from C would meet it. From D draw a line 34 rods southeast to a point E. 32 rods south of B. Connect E and C. How many trees in a row along E C, one rod apart, the first $8\frac{1}{4}$ feet northeast of point E?

17. The boundary line of a town is as follows: Beginning at the northwest corner A, extending east 27 miles to B. Turning at B and running 9 miles in a southwesterly direction to C. From C, extending directly west 27 miles to D. From D to point of beginning. What is the length of the town's boundary lines? (Scale, 2 inches to 9 miles).

CARPETING FLOORS.

1. A room is 12 feet wide and 21 feet long. How many yards of carpet 1 yd. wide must I buy to carpet the floor?

NOTE.—Since the room is 12 feet wide, it will take four breadths, each 21 feet or 7 yards long, 28 yards in all.

2. A room is 13 feet wide; how many breadths will it take? How many yards if 21 feet long?

NOTE.—It will take five breadths and two feet must be folded under, and 5 times 7 yards are 35 yards.

3. How many yards must be bought for a room 14 feet wide and 21 feet long?

4. How many yards must be bought for a room 15 feet wide and 24 feet long?

5. How many yards must I buy for a room 18 feet square?

6. How many yards must I buy for a room 20 feet wide and 30 feet long?

7. How many yards of carpeting $\frac{3}{4}$ of a yard wide, must I buy for a room $13\frac{1}{2}$ feet wide and 21 feet long?.

NOTE.—Since the carpet is $\frac{3}{4}$ yards wide it is $2\frac{1}{4}$ feet wide or $\frac{1}{2}$ feet. The room being $13\frac{1}{2}$ feet wide it is $\frac{54}{4}$ feet wide. Then it will take as many breadths as there are $\frac{1}{2}$ feet in $\frac{54}{4}$ feet or 6. 6 times 7 yards equals 42 yards which I must buy.

8. A room is 15 feet wide and 27 feet long. How many yards of carpet must I buy for it? Carpet $\frac{3}{4}$ yard wide.

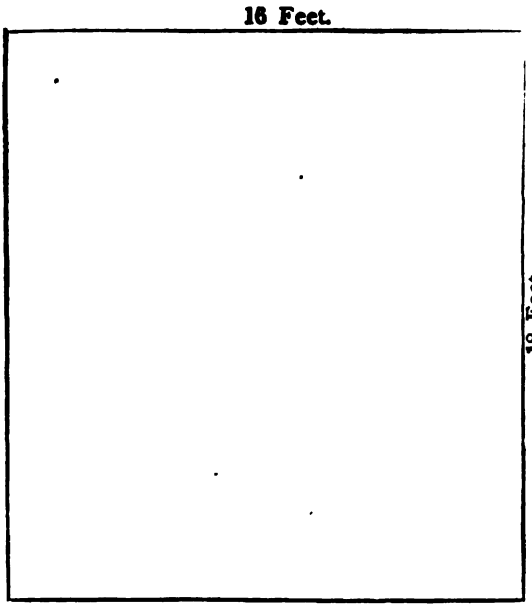
NOTE.—$\frac{9}{2} \div \frac{1}{2} = 6\frac{1}{2}$. Hence, 7 breadths must be bought unless the carpet man is willing to split a breadth. 7 times 9 yards equals 63 yards.

10. A room is 16 feet square, how many yards of carpet $\frac{3}{4}$ yard wide must I buy for the floor of the room?

11. If Mr. A. has a room 22 feet long, and 18 feet wide; how many yards of carpet $\frac{3}{4}$ yard wide must he buy for its floor?

12. My hall is 3 feet wide and 15 feet long. What will it cost to carpet it at $1.25 a yard with carpet $\frac{3}{4}$ yard wide, if I use only one breadth?

Do not use a pencil.



13. How many yards of carpet, $\frac{3}{4}$ yard wide, must I buy for the floor of a room of which this is a plan? the breadths are to run east and west.

14. How many yards if the breadths run north and south?

15. How many yards if the carpet is 1 yard wide and the breadths run east and west?

16. How many yards if the breadths run north and south?

SUPPLEMENTARY WORK

—IN—

ARITHMETIC

PART TWO.

AREA

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TO THE TEACHER.

From the first, without saying so, impress the children with the fact that finding the area of any figure is simply finding the number of square units on its surface, which are always in rows, with a given number of units in a row. Never tell them to multiply the length by the breadth, because if the length is 4 inches and breadth is 3 inches, you are telling them to multiply 4 *inches* by 3 *inches* and they at once infer that inches multiplied by inches give square inches, which is just as absurd as to say that eggs multiplied by eggs give *square* eggs! In multiplication the product has the same name as the multiplicand, which, when finding area, is always a square unit.

There is no good reason why Mensuration, one of the most interesting subjects in arithmetic, should not be taught from the first, instead, as is too often the case, to only eighth year pupils and then not till the last half of the year. And, when taught, a new rule is given for every plane figure. There should be but one thought when a question in area is asked, viz: "Where is the rectangle?" If the child has been lead to discover this truth, he will not burden his memory with a score or more rules, nor will he think there is no relation between one form and another, but will see that they are all of the same family. I have yet to see a child who is not perfectly delighted when making new discoveries for himself.

LESSON I.

NOTE.—Write all new words used, on the board. Erase, *at once*, and have the children write them. After, use them often in their reading lessons.

1. Cut me out a piece of paper 1 inch wide and 2 inches long.
2. Fold the paper so that the short edges will meet. What have you made?
3. Show me one row of 2 square inches.
4. Cut out a piece of paper 1 inch wide and 4 inches long.
5. Fold the paper so that the short edges will meet. Crease and open. Now fold so that one of the short edges will meet the center crease. Now fold so that the other short edge will meet the center.
6. Fold the paper so as to make 1 square inch.
7. Show me one row of 2 square inches.
8. Show me one row of 3 square inches.
9. Show me one row of 4 square inches.
10. Cut out a piece of paper 2 inches long and 2 inches wide.
11. Fold so that two edges will meet. Crease and open. Fold so that the other two edges will meet. Crease and open.
12. Fold so as to show me 1 square inch.
13. Fold so as to show me one row of 2 square inches.
14. Show me two rows of 2 square inches. How many square inches is that? Or, I may say, what is the *area* of the paper in square inches?
15. One square inch is what part of the area? Two square inches are what part of the area? Tell me another way. Then two-fourths equal what?
16. Three square inches are what part of the area? Four square inches? Tell me another way? Then how many fourths in one whole?
17. One row is what part of the area?
18. One square inch is what part of one row? Then one-half of one-half is what part of the whole?
19. How many square inches in a two-inch square?

LESSON II.

1. Show me a piece of paper 2 inches wide and 4 inches long.
2. Fold the paper so that the short edges will meet. Crease and open.
3. Now fold the paper so that one of the short edges will meet the crease in the center. Crease and open.
4. Fold the paper so that the other short edge will meet the crease in the center. Crease and open.
5. Fold the paper so that the long edges will meet. Crease and open.
6. Fold the paper so as to make 1 square inch.
7. Show me one row of 2 square inches.
8. Show me one row of 3 square inches. One row of 4 square inches.
9. Show me two rows of 4 square inches each. How many 4 square inches have you? How many square inches?

LESSON III.

1. Show me the paper containing two rows of 4 square inches. How long is it? How wide is it? What is its perimeter?
2. One row of the square inches is what part of the surface or area?
3. Two square inches are what part of the surface or area?
4. Three square inches are what part of the surface? Four square inches are what part of the surface or area?
5. Five square inches are what part of the surface? Six? Seven? Eight?
6. One square inch is what part of one row? And one row is what part of the whole? Then one-fourth of one-half equals what? Two-fourths of one-half equals what?

7. How many 1 square inches in the surface? How many 2 square inches in the surface?

8. How many 4 square inches in the surface? How many 8 square inches in the surface?

9. If one row be taken away how many square inches are left?

10. If 1 square inch be taken how many remain? If three? If two? If five? If six? If seven? If eight?

LESSON IV.

1. A square contains 9 square inches. How long and wide is it?

2. An oblong contains 9 square inches. How wide and long may it be?

3. Cut a piece of paper just large enough to contain 12 square inches.

4. Who cut a piece 1 by 12 inches? Who cut one 2 by 6 inches? Who cut one 3 by 4 inches?

5. I have a paper containing 14 square inches. How wide and long may it be?

6. I have a piece of paper containing 15 square inches. How wide and long may it be?

7. Make a rectangle containing just as many rows as there are square inches in a row. How large is the *square* you have made?

8. How many square inches in an oblong 3 by 6 inches? What does 3 by 6 inches mean? It means that there are — rows and that there are — square inches in a row and *three* 6 square inches are — square inches.

9. Tell me of another surface that contains 18 square inches. Of still another.

10. Draw a four-inch square. Divide it into square inches. How many square inches are there? How many rows of square inches? How many square inches in a row?

LESSON V.

1. Show me the four-inch square. One row is what part of all the square inches? Two rows are what part? Three rows are what part? Four rows?

2. One square inch is what part of the square inches? Two square inches are what part? Three? Four? Five? Six?

3. How many 2 square inches in a two-inch square? How many 4 square inches?

4. How many 8 square inches in a four-inch square? How many 16 square inches? How many 4 square inches?

5. How many 3 square inches in a four-inch square? How many 5 square inches? How many 7? How many 9 square inches?

6. Take away 1 row and how many square inches are left? Take 2 rows? Take away 3 rows? Four rows?

7. Take away one 2 square inches and how many square inches are left? One 3? One 8? One 9? One 7?

8. How many square inches on the face of a card board that is

3 by 4 inches?	3 by 9 inches?
3 by 6 inches?	3 by 8 inches?
3 by 5 inches?	3 by 2 inches?
3 by 7 inches?	3 by 3 inches?

NOTE—Excellent lessons in fractions may be given on each of these questions, e. g. the rectangle 3 × 4 contains how many square inches? One horizontal row is what part of the area? How many twelfths is that? Then $\frac{1}{3}$ equals how many twelfths? Where do thirds and twelfths meet? How many horizontal rows are there? Three-thirds equal how many twelfths? One vertical row is what part of the area? How many twelfths is that? Then $\frac{1}{4}$ equals how many twelfths? Where do fourths and twelfths meet? Where do thirds, fourths and twelfths meet? What else can be seen on the rectangle? If we are to add $\frac{1}{2}$, $\frac{1}{3}$, $\frac{1}{4}$ and $\frac{1}{12}$, of what shall we think? ($\frac{6}{12}$, $\frac{4}{12}$, $\frac{3}{12}$ and $\frac{1}{12}$) How many twelfths will that make? What do $\frac{14}{12}$ equal? Who can find $\frac{1}{3}$ of $\frac{1}{4}$? How many twelfths is that? $\frac{1}{4}$ of $\frac{1}{3}$ = ? $\frac{1}{3}$ of $\frac{1}{2}$ = ? $\frac{1}{2}$ of $\frac{1}{2}$ equals how many twelfths? How many sixths can be seen in the rectangle? How many twelfths in each $\frac{1}{6}$? $\frac{1}{2}$ of $\frac{1}{6}$ = ?

9. How long must a card board be to contain 20 square inches, if 4 inches wide? (See note page 10.)

12 square inches, if 3 inches wide?
18 square inches, if 3 inches wide?
15 square inches, if 3 inches wide?
21 square inches, if 3 inches wide?
27 square inches, if 3 inches wide?
24 square inches, if 3 inches wide?

10. If a card board is 3 by 4 inches, how many rows of square inches does it have? How many square inches in each row? If it is 3 by 3 inches? 3 by 7 inches?

If it is 3 by 6 inches? If it is 3 by 5 inches?
If it is 3 by 8 inches? If it is 3 by 9 inches?

NOTE—Hold papers the different sizes as indicated in the questions, before the class and let the children judge the area of each. This is an excellent exercise and should be frequently given. The teacher will notice that questions 8, 9 and 10 are a good review of three's table in multiplication and partition. All the tables may be reviewed in the same way. Room need not be taken for them here.

LESSON VI.

1. Cut a piece of paper 1 inch wide and 4 inches long. Fold it so as to make 1 row of 4 square inches.

2. Make the sides of a box of the paper. How long is each side of the box?

3. How deep is the box?

4. How many inches around the box? Place the box on your desk so as to make a rectangle.

5. How long is the rectangle? How many inches was it around the box? Show me a paper 8 inches long and 2 inches wide. Fold so that the short edges will meet. Crease and open. Fold so that

one of the short edges will meet the crease in the center. Crease and open. Fold so that the other short edge will meet the crease in the center. Crease and open. Make the four sides of a box with your paper. How long is each side? How wide? Make a rectangle of the sides of the box.

6. The sides and ends of the box make a rectangle how long? How wide?

7. I have a box 2 inches long, 1 inch wide and 1 inch deep. What kind of a rectangle will it make? It will make a rectangle that is — inches long and — inches wide.

8. How many square inches in the rectangle? Then how many square inches on the sides and ends of a box that is 2 inches long, 1 inch wide and 1 inch deep?

9. I have a box that is 2 inches long, 2 inches wide, and 1 inch deep. What kind of a rectangle will its sides and ends make?

10. A box is 2 inches long, 2 inches wide, and 2 inches deep. What kind of a rectangle will its sides and ends make?

11. If the box will make a rectangle 2 by 8 inches, how many square inches on its sides and ends?

12. Another box is 2 inches wide, 3 inches long, and 2 inches deep. How many square inches on its sides and ends? How many on a box 4 by 3 by 2?

13. How many square inches are there on the bottom of the box 2 by 3 by 2?

14. How many square inches on the sides and bottom of the box?

15. How many square inches on the sides, ends, top and bottom of a box 2 by 3 by 2 inches?

16. What part of its square inches is on one of its ends? On two ends? On one side? On two sides? On its top? On its bottom? On its top and bottom?

NOTE.—Ex. 9, page 9. There must be 4 rows. One row $= \frac{1}{4}$ of 20 square inches $= 5$ square inches. A row to contain 5 square inches must be 5 inches long.

SUGGESTIVE QUESTIONS ON CHART XVII.

LESSON I.

1. See Fig. 31, which shows one of the four equal sides of a box. How many square inches on its sides and ends?

NOTE.—In these questions reference is had to the *outside* only.

2. How many square inches on its cover?
3. How many square inches on one side?
4. How many square inches on two sides?
5. How many square inches on one end?
6. How many square inches on its two ends?
7. Fig. 31 shows one of the ends of a box, and Fig. 32 shows one of the sides of the same box. How many square inches on its two sides and two ends?
8. How many square inches on the sides and ends of a box of which Fig. 32 is one of the four equal sides?
9. Fig. 33 is one of the sides of a box of which Fig. 31 is one of the ends. How many square inches on its sides and ends?
10. How many square inches on the sides and ends of a box of which Fig. 33 is one of the sides and Fig. 32 is one of the ends?
11. What part of the square inches is on one side of the last box? On two sides? On one side and end? On one end? On two ends?

LESSON II.

12. Fig. 33 is one of the four equal sides of a box. How many square inches on its sides and ends? What part is on one side?
13. On its sides, ends, and top there are how many square inches? (See question 12.)
14. Fig. 34 is one of the ends of a caramel box which is just half as wide as it is long. How many square inches on its sides and

CHART XVII.

(See Part One, on Lines, for Charts from 1 to XVI.)

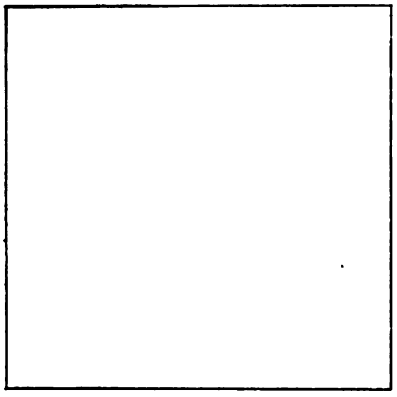


Fig. XXXI.

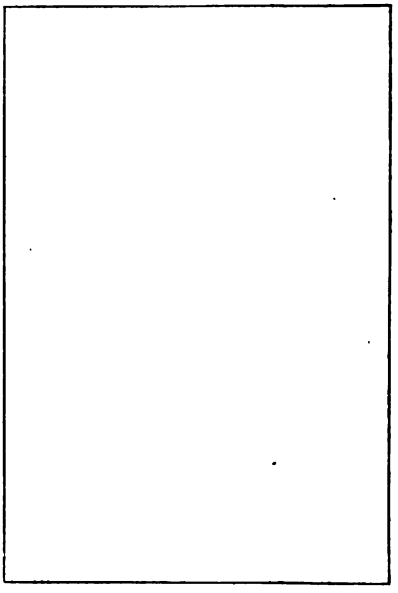


Fig. XXXII.

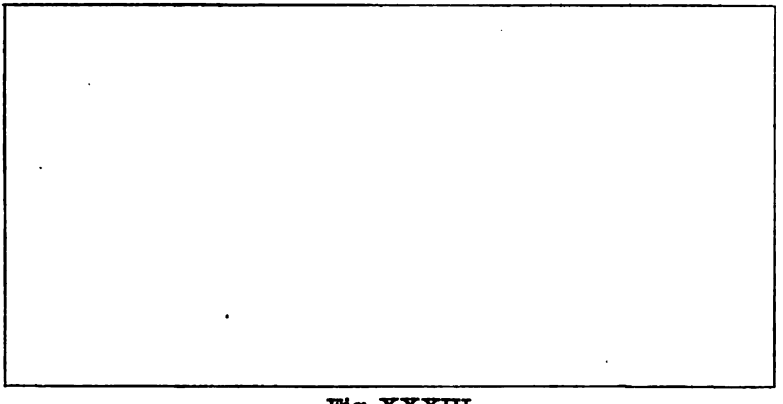


Fig. XXXIII.

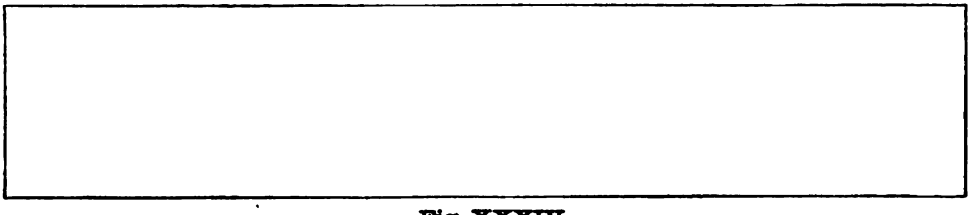


Fig XXXIV.

ends? What part of them is on one side? What part is on one end? On one side and end?

15. How many square inches on the top of a box of which Fig. 34 is one side, and whose ends are one-half as wide as the length of the box?

16. How many square inches on the sides and ends of two boxes when Fig. 31 is one of the four equal sides of one of them, and Fig. 32 is one of the four equal sides of the other?

17. If I have a box with Fig. 33 one of the four equal sides of it, and I take off one end, how many square inches are left? If one side is taken off? One side and one end?

18. Fig. 34 is one of the four equal sides of a box. How many square inches on its sides, ends, and top? If I take off the top, how many square inches are left? What part of the square inches did I take? What part is left?

NOTE.—The teacher may designate any figure or figures in the following problem. Or she may use one as a lesson for home work.

19. How many 2 square inches in the sides, ends and top of a box of which Fig. (?) is one of the four equal sides? How many 3 square inches? How many 4 square inches? Five? Six? Seven? Eight? Nine? Ten?

20. How many more 3 square inches than there are 10 square inches? How many more 4, than 9? How many more 5, than 8?

21. How many dozen square inches on the sides and ends of a box of which Fig. 33 is one of the sides and Fig. 31 is one of the ends? How many more than a score is that?

22. What part of 2 dozen is 1 score?

22. One dozen is what part of a score?

24. One and one-half dozen is what part of a score?

CHART XVIII.

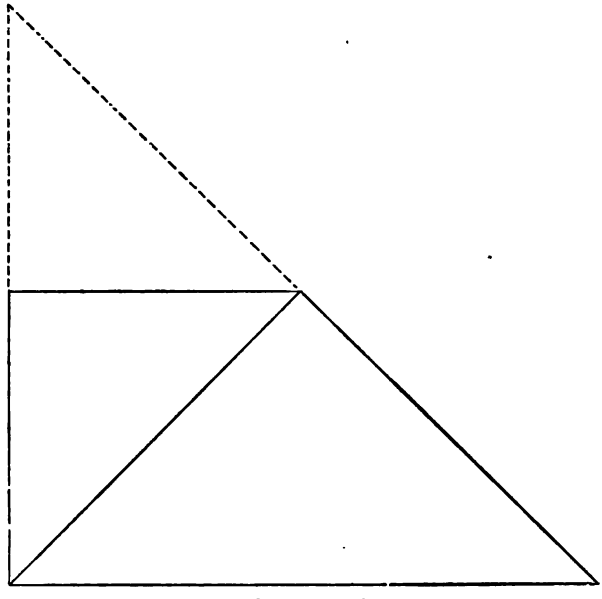


Fig. XXXV.

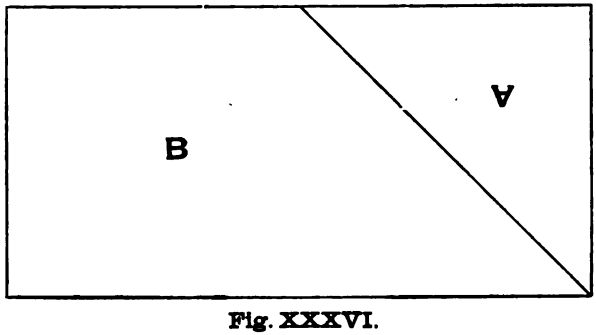


Fig. XXXVI.

SUGGESTIVE QUESTIONS ON CHART XVIII.

You may take your papers and cut out a right triangle with a base and altitude each 4 inches long. (One good way is to cut out a 4 inch square and then cut through its diagonal.) Show me the triangle. Fold the triangle so that the vertex of the upper angle will meet the vertex of the right angle. See Fig. 35. Crease and open. Mark the upper part A and the lower part B. Tear off A. Now place it next to B so that its oblique side will be next to B's oblique side and A will be upside down. See Fig. 36.

What have you made? Compare the rectangle with the triangle.

NOTE.—The rectangle has the same base as the triangle and an altitude equal to one-half the altitude of the triangle.

SUGGESTIVE QUESTIONS ON CHART XIX.

1. Cut out a rectangle 2 by 4 inches. How many rows of square inches does it contain? How many square inches in a row? Then how many square inches?

2. One inch from the upper right hand corner make a point. Also make a point one inch from the upper left hand corner. Next make a point in the middle of the lower or base line. Connect the middle point with the other two points. Into how many parts have you divided the rectangle? Name them A, B, and C. See Fig. 37.

3. Cut the rectangle into the three parts. Now place the part A so that its vertical side will be next to the vertical part of C. Then place B over A and C, so that B will be upside down. See Fig. 38. What have you made? What kind of a triangle? Change it to a rectangle again.

4. How many square inches did the rectangle contain? Then how many must the triangle contain?

5. How long was the base of the rectangle? How long is the base of the triangle?

CHART XX.

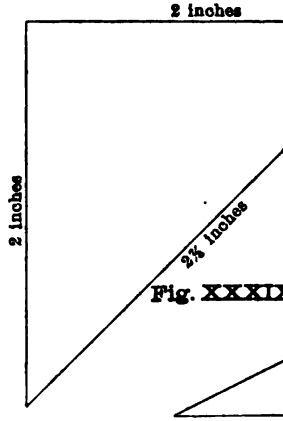


Fig. XXXIX.

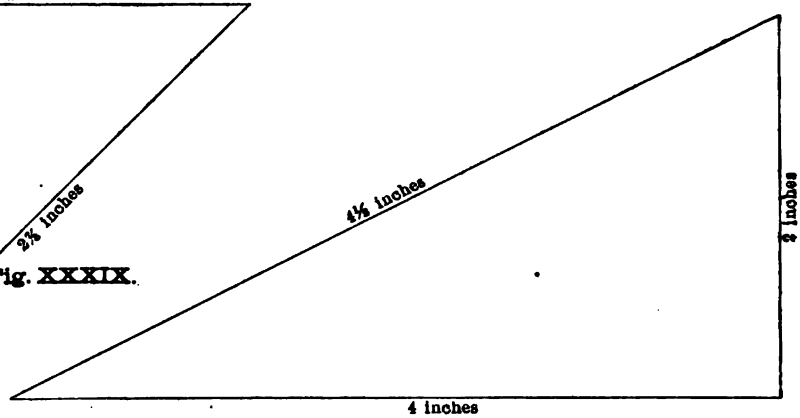


Fig. XL.

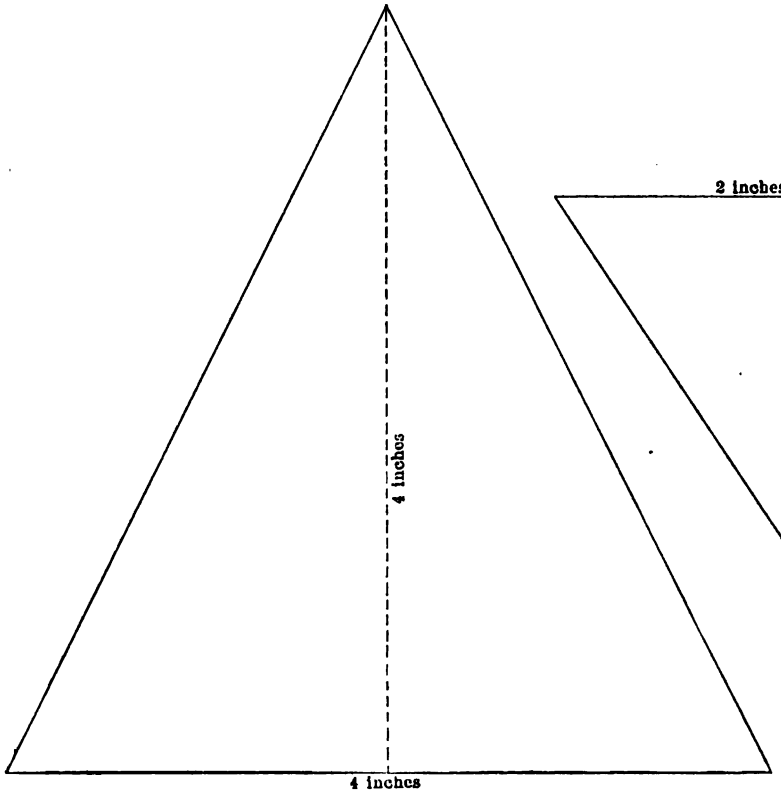


Fig. XLI.

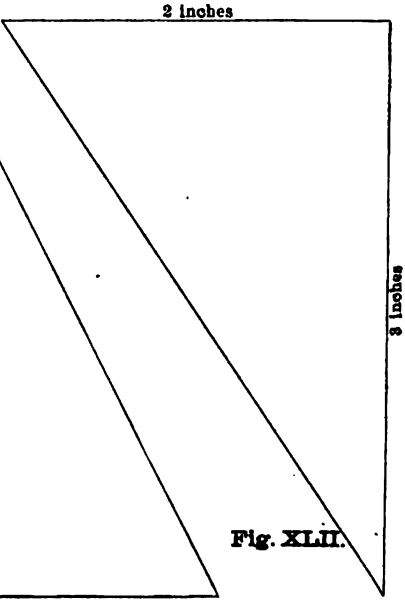


Fig. XLII.

6. How high was the rectangle? Or, we may ask, what was its altitude? What is the altitude of the triangle?

7. Read this and fill in the blank places:

A triangle can be made into a rectangle with a base — — — — — and an altitude — — that of the —.

8. Cut out a scalene triangle. See if this can be made into a rectangle with a base the same as the triangle and an altitude equal to one-half that of the triangle. (Let this be home work.)

SUGGESTIVE QUESTIONS ON CHART XX.

1. See Chart XX, Fig. 39. Into what rectangle can you see it? Into what rectangle can you see Fig. 40? Fig. 41? Fig. 42? What is the area of Fig. 39? Of 40? Of 41? Of 42?

2. What is the sum of all the areas?

3. The area of Fig. 39 is equal to what part of the area of Fig. 41?

4. The area of Fig. 39 is equal to what part of the area of Fig. 40?

5. The area of Fig. 39 is equal to what part of the area of Fig. 42?

NOTE.—If the class has had percentage the question may be put as follows: 39 equals what per cent of 40? Of 42? Of 41?

6. To how many half-inch squares is the area of Fig. 39 equal?

7. The area of Fig. 40 is equal to how many half-inch squares?

8. The area of Fig. 41 is what part of the sum of all the areas?

9. The area of Fig. 40 is what part of the sum of all the areas?

10. The area of Fig. 39 is equal to what part of the sum of all the areas less the area of Fig. 42?

11. To how many half-inch squares is the area of Fig. 41 equal? 32 ans.

12. To how many half-inch squares is the area of Fig. 42 equal?

13. A triangle having a base 12 inches and an altitude 6 inches is equal in area to what rectangle?

14. To what rectangle is a triangle equal, whose base is 16 inches long and whose altitude is 12 inches long?

CHART XIX.

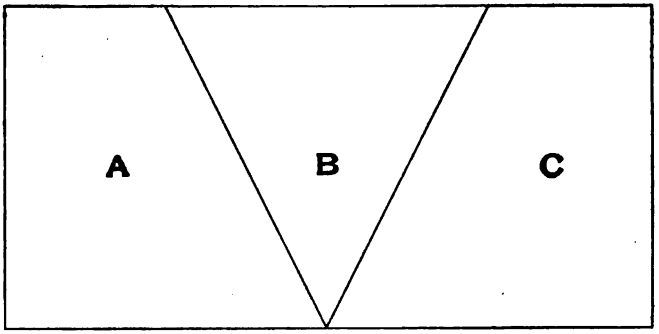


Fig. XXXVII

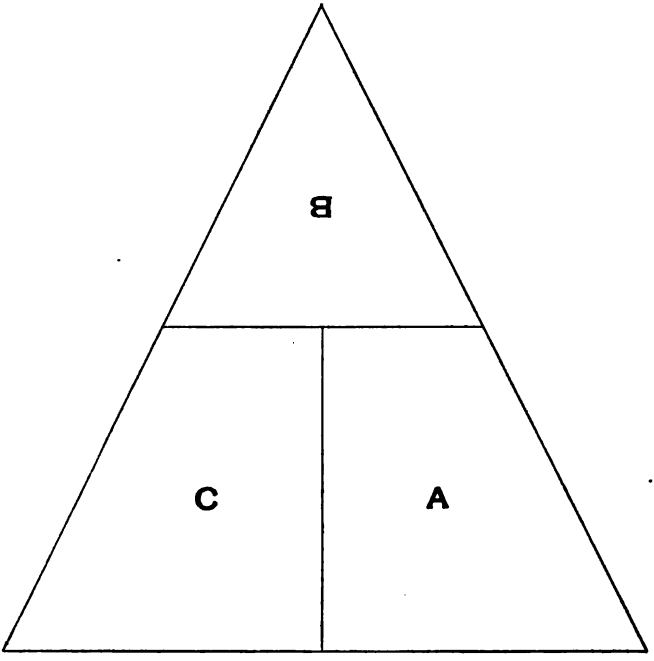


Fig. XXXVIII.

READING LESSON I.

1. In a rectangle 6 inches wide and 6 inches long, there are — rows of — square inches or — square inches.

2. In a triangle whose base is 6 inches and whose altitude is 6 inches, there are — rows of — square inches. We know this because the triangle may be made into a rectangle with a base the — — — — and an altitude just — — — the triangle.

3. When told to find the area of a triangle with a base 8 inches and an altitude 7 inches, I see a rectangle — inches long and — inches high. Or — rows of — square inches.

4. The area of a triangle with a base 12 inches long and an altitude 8 inches high is the same as that of a rectangle — inches long and — inches wide. Or there are — rows of — square inches, or — square inches.

5. To find the area of a triangle with a base of 14 inches and an altitude of 10 inches, I think of a rectangle containing — rows of — square inches each, or — square inches.

6. When a triangle has a base of 16 inches and an altitude of 12 inches, I find its area by thinking of a rectangle containing — rows of — square inches or — square inches.

7. In an inch square there are — one-half inch squares.

8. If a rectangle contains 3 square inches, it contains — one-half inch squares.

9. One-half of one-inch square contains — one-half inch squares.

10. A triangle with a base of 4 inches and an altitude of 4 inches contains — square inches and — one-half inch squares.

11. A box 3 inches long, 1 inch deep, and 2 inches wide, has on its four sides — square inches. The sides and ends of the box make a rectangle with — row of — square inches.

12. In division the dividend and divisor have the — name. Then to find how many $\frac{2}{3}$'s in $\frac{5}{6}$ we must change the thirds and sixths to — and then say how many — in —.

CHART XXI.

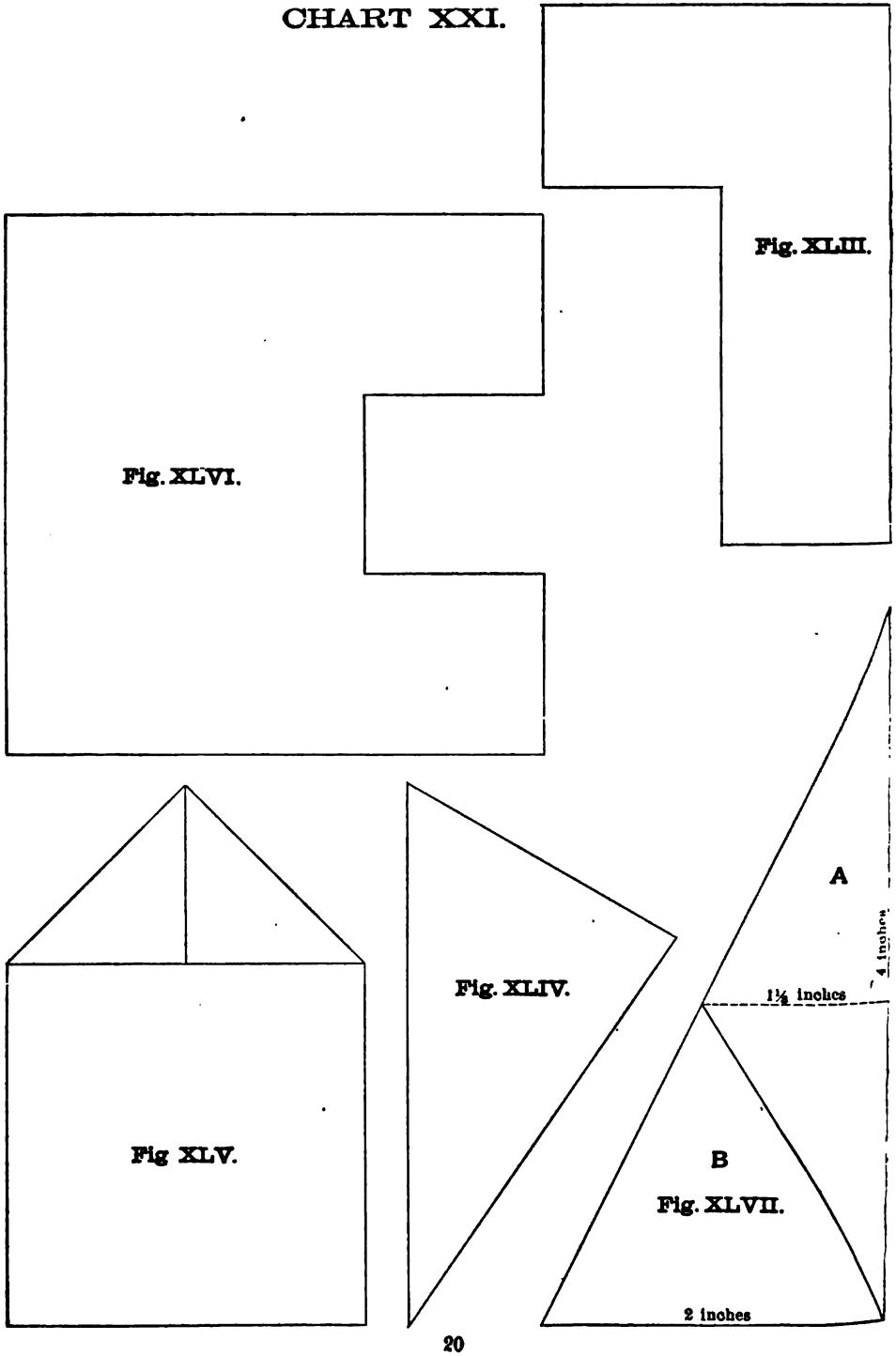


Fig. XLIII.
Fig. XLVI.
Fig. XLV.
Fig. XLIV.
A
4 inches
1½ inches
B
Fig. XLVII.
2 inches

15. What is the area of a triangle with a base 8 inches long and an altitude 7 inches long?

NOTE.—It often happens, as in this case, that we avoid a fraction by taking half the base instead of half the altitude.

SUGGESTIVE QUESTIONS ON CHART XXI.

1. What is the area of Fig. 43?
2. What is the area of Fig. 44?
3. What is the area of Fig. 45?
4. What is the area of Fig. 46?
5. What is the area of Fig. 47?
6. What is the area of A in Fig. 47? Then what must be the area of B?
7. What is the sum of all the areas?
8. One square inch is equal to what part of Fig. 43's area?
9. One square inch is equal to what part of Fig. 44's area?
10. One square inch is equal to what part of A's area? See Fig. 47.
11. One square inch is what part of Fig. 45's area? Two square inches? Three?
12. One square inch is what part of the area of Fig. 46?
13. B's area is equal to what part of A's area?

NOTE.—A equals $\frac{9}{4}$ and B equals $\frac{7}{4}$. Then the question is, 7 = what part of 9, just as it would be had $\frac{7}{4}$ been $\frac{7}{8}$ and had $\frac{9}{4}$ been $\frac{9}{8}$, i. e., \$7 equals what part of \$9? In both cases the denominators (namers) tell what we are comparing, and if so understood do not tend to confuse. I say $\frac{1}{3}$ is what part of 3. I can compare only like things. Hence I must make them alike in this question, and then I ask, $\frac{1}{3}$ is what part of $\frac{9}{3}$, or 1 is what part of 9, and the answer is $\frac{1}{9}$.

14. B's area is equal to what part of Fig. 44's area?
15. B's area is equal to what part of the area of Fig. 43?
16. The area of Fig. 47 is what part of the area of Fig. 47 plus the area of Fig. 46?
17. The area of 45 equals what part of the area of 46?
18. The area of 44 equals what part of the area of 45?

READING LESSON II.

NOTE—The square of a number, e. g., 3, should mean something more to the child than 3 "*times*" 3. The following questions are given to suggest what may be done in order to make it mean something.

13. If a rectangle contains just as many rows as there are square inches in a row it is called a —.

14. A square always contains as many square units in a row as it has —.

15. A square always contains as many rows as there are — — in each row.

16. When I am told to square 2, I am to think of a square having 2 rows with 2 square units in a row. The square units may be square inches, square feet, square yards or square rods.

17. If the square is 2 inches long, the square units will be — —. If it is 2 feet long, the square units will be — —. If the square is 2 yards long, the square units will be — —. If the square is 2 rods long, the square units will be — —.

18. When I am told to square 3, I am to think of a square having — rows with — square units in a row. Its area will contain — square units.

20. When a square contains 9 square inches, it has — rows with — square inches in a row. Its sides are each — inches long.

21. When a square contains 16 square inches, it is — inches long and — inches wide.

22. When a square contains 9 square inches, the number of its rows or the number of units in a row is the *square root* of 9. The square root of 9 is —.

23. The square of 3 is —.

24. The square of 2 is —.

25. The square of 4 is —.

26. The square root of 9 is —.

27. The square root of 4 is —.

28. The square root of 16 is —.

CHART XXII.

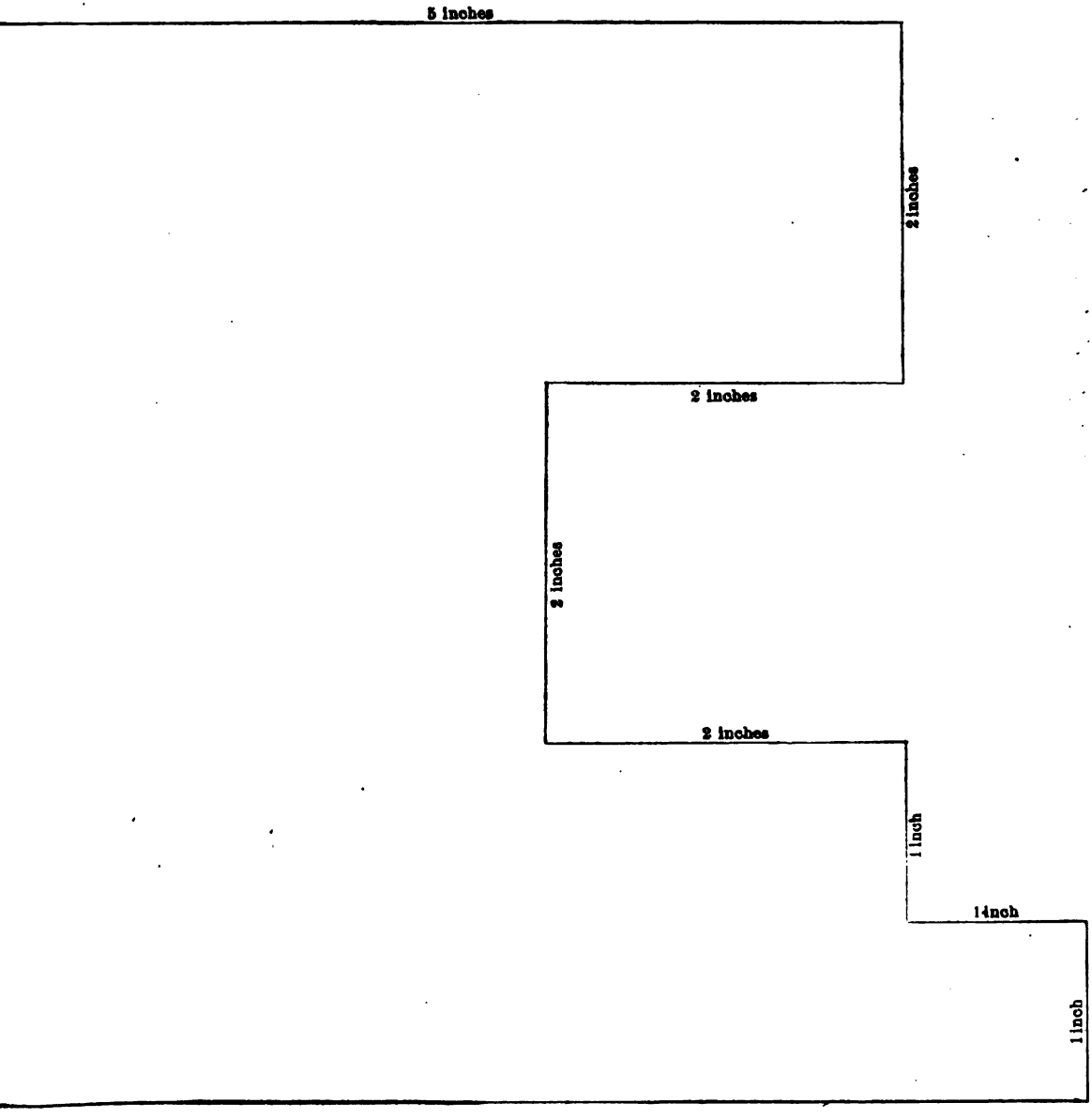


Fig. XLVIII.

SUGGESTIVE QUESTIONS ON CHART XXII.

LESSON I.

1. See Fig. 48. It is a plan of the ground floor of May's doll house. How long is the north side?
2. How long is the south side?
3. How long is the west side? What is the perimeter?
4. How many square inches does this ground floor contain?

NOTE—Have each child tell how he found the 27 square inches. It will be interesting to see the different ways of looking at it.

5. See if you can work it five different ways.
6. Now look at Chart 23 and you will find how May divided it into rooms. How odd! How many square inches were in the floor of room F? Keep your answer.
7. How many square inches in the floor of room E?
8. How many square inches in the floor of room D?
9. How many square inches in the floor of room C?
10. How many square inches in the floor of room B?
11. How many square inches in the floor of room A? In a few weeks we shall learn another way to find the area of A's floor. See if you can tell your teacher when the time comes.
12. Prove that your answers are right. How many square inches did Fig. 48 contain?
13. The sum of the areas of four of the rooms is equal to one dozen square inches. Which four rooms are they?

LESSON II. CHART XXIII.

14. A's area is what part of the whole area?
15. A's area is equal to what part of D's area?
16. To what part of C's area is A's equal?
17. To what part of E's area is A's equal?

CHART XXIII.

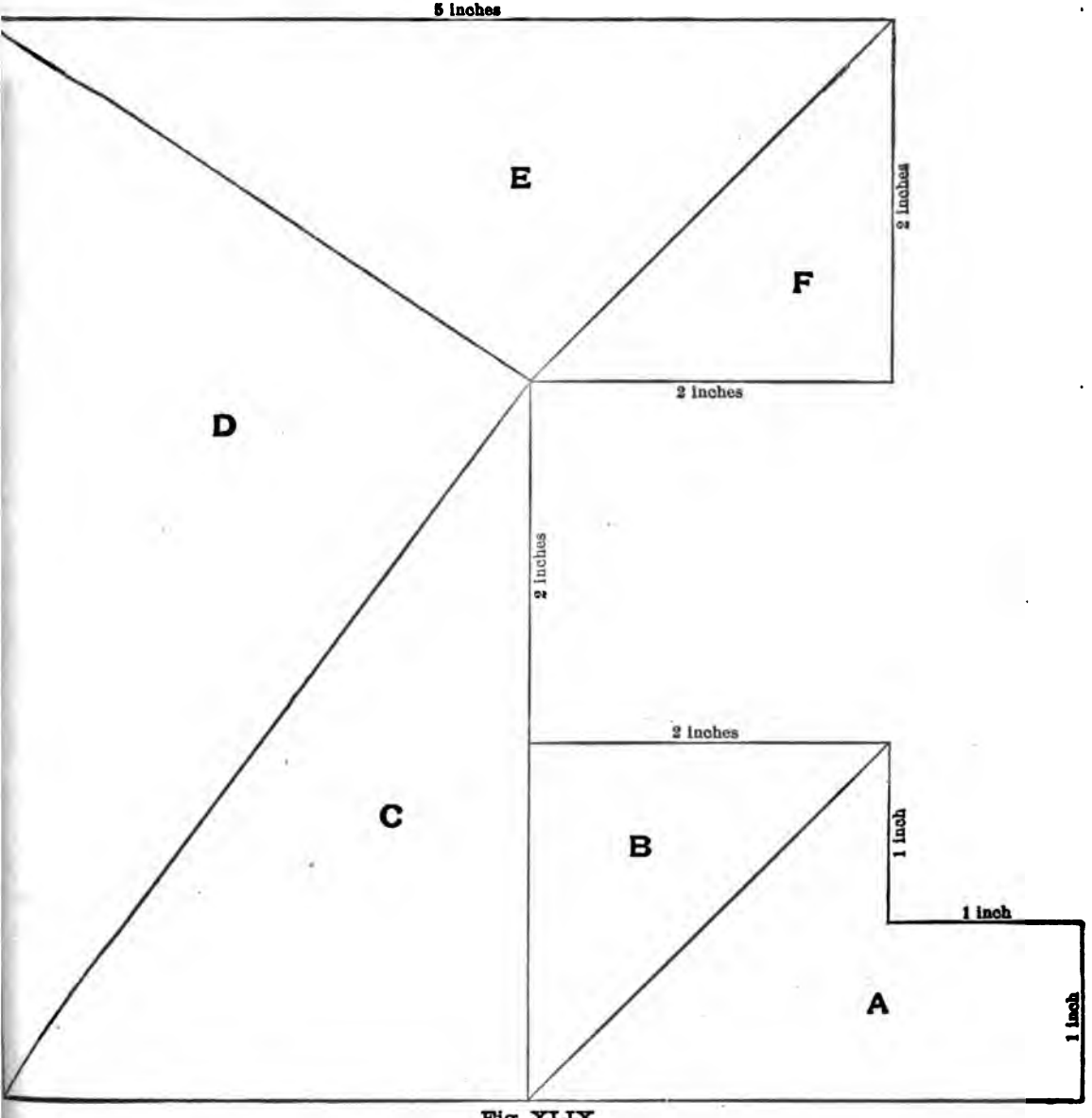


Fig. XLIX.

18. Which room's area is one-third of the whole area?

19. Which room's area is two-ninths of the whole area?

20. The area of which room is equal to .1 of a score of square inches?

21. The area of which room is equal to one-fourth of a score of square inches?

22. The area of one room is equal to three-fourths of a dozen square inches. Which room is it?

SUGGESTIVE QUESTIONS ON CHART XXIV.

NOTE.—Provide the children with paper large enough to take the following exercise. Old newspapers are not bad if nothing better can be obtained.

1. Cut out a paper 1 foot long and 1 foot wide. What did we call the surface that had each edge 1 inch long? A square ——. Then what shall we call this surface that has each edge 1 foot long? A square ——.

NOTE.—The following problems should now be worked without pencils. The children will thus form the habit of seeing a picture when working such problems. Review the area of boxes and lead the pupils to see the four walls as a rectangle, just as they do the four sides of a box. (See cut, page 91.)

2. I have a room 10 feet by 20 feet and 10 feet high. How many square feet on its 4 walls?

3. A room is 20 by 24 feet and 10 feet high. Its 4 walls contain how many square feet?

4. A hall is 3 by 15 feet and 10 feet high. How many square feet on its 4 walls?

NOTE.—Draw a square yard on the black board.

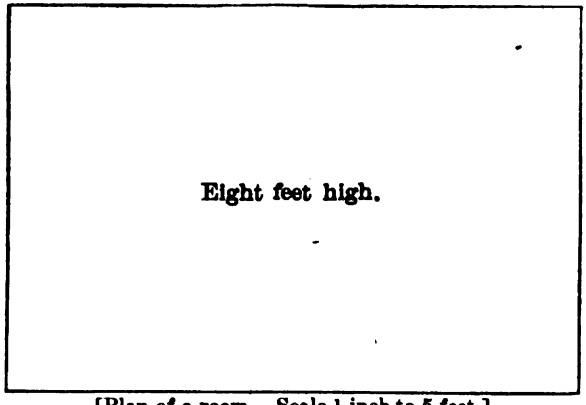
5. How many square yards on the 4 walls of the room? (Ex. 4.) What will it cost to plaster it at 20c. per square yard?

6. A bed room is 16 by 20 feet and 10 feet high. At 50c. a square yard what will it cost to lath and plaster the 4 walls? How many square feet in the ceiling of this room?

7. A room is 9 feet square and 10 feet high. What will it cost to lath and plaster its walls at 25c. per square yard?

NOTE.—Some contractors make no deduction for windows and doors, while others do.

WRITTEN WORK. LESSON II.



[Plan of a room. Scale ¼ inch to 5 feet.]

1. How many square feet in the four walls and ceiling of the room of which the above is a plan? 4000 Ans.

2. A room is 10 feet high and 36 feet square. What will it cost to lath and plaster its walls at 25 cents per square yard?

3. A parlor is 24 feet square, the height of the walls is 12 feet, 342 square feet are to be taken out for windows and doors. What will it cost to lath, plaster, and tint the walls, at 60 cents per square yard?

4. At 30 cents per square yard, what will it cost to tint the walls and ceiling of a room 10 feet square and 5 feet high?

CHART XXIV.

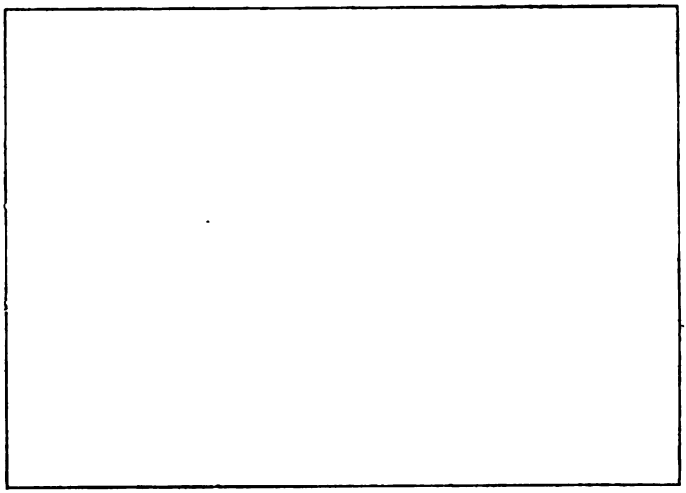


Fig. L.

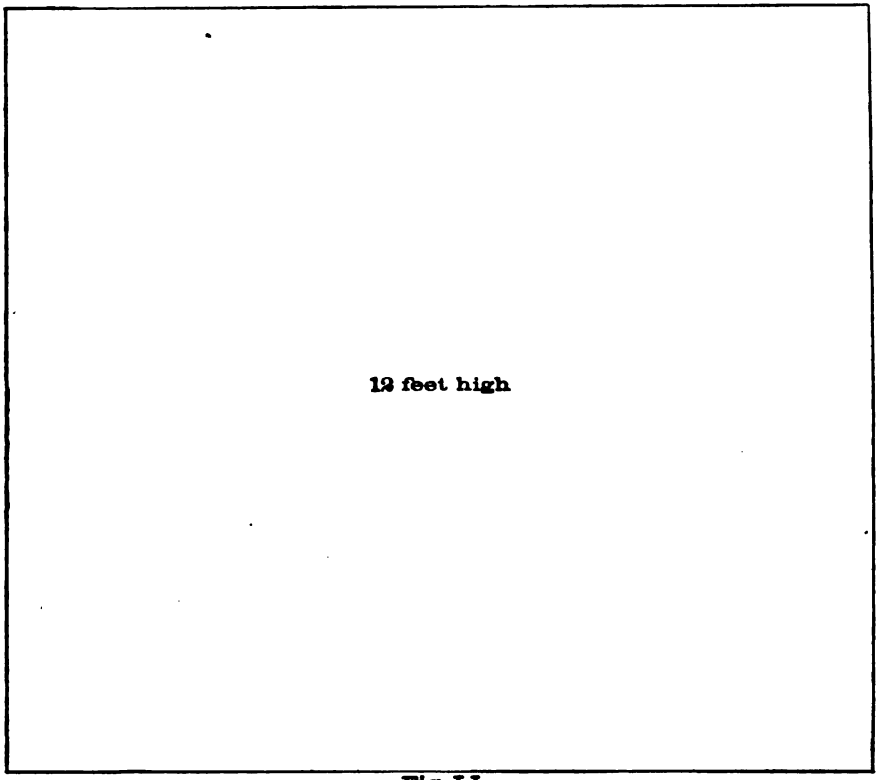


Fig. LI.

5. Our charts are not large enough to show a square foot or a surface containing any number of square feet. We shall then use a scale as in Example 1. See Fig. 50, Chart XXIV. This is a plan of a room (scale, $\frac{1}{2}$ inch to 2 feet). How long is the room? How wide is it?

6. How long a rectangle will its sides and ends make? If the walls are 10 feet high, how many square feet do they contain?

7. How many square feet on the 4 walls of a room of which Fig. 51 is a plan (scale, $\frac{1}{4}$ inch to 1 foot)?

8. How many square feet in the ceiling of the room? (Fig. 51.) How many square feet on the 4 walls and ceiling?

9. The area of the 4 walls of the room shown by Fig. 50, is equal to what part of the whole area of the room shown by Fig. 51?

LESSON III. CHART XXIV.

2. How many more square feet on the four walls of a room like Fig. 51 than on the four walls of a room like Fig. 50?

3. How many more square feet in the ceiling of Fig. 51 than in the ceiling of Fig. 50?

4. How many 5 square feet in the four walls of Fig. 50? How many 10 square feet?

5. How many 3 square feet in the four walls of Fig. 51? How many 12 square feet?

6. The square feet in the ceiling of Fig. 50 equal what part of the square feet in its four walls?

7. How many square feet in the walls and ceilings of Figs. 50 and 51?

8. The square feet in the ceiling of Fig. 50 equal just four-fifths of the square feet in the ceiling of another room. How many square feet in its ceiling?

9. There are 24 square inches of colored glass across the top of a window. If this is divided into 4 panes, how many square inches in each, and what are the dimensions of each pane?

10. John has a piece of tissue paper 6 inches long and 4 inches wide. If he gives Mary $\frac{3}{4}$ of it, how many square inches will he have left?

11. Our hall is 4 feet wide and 6 feet long. The floor is of marble blocks of 2 colors, each 1 foot square. How many blocks of each color? How many in all?

12. Mary has a piece of ribbon 12 inches long which contains 24 square inches; how wide it it?

13. I have a piece of chamois skin that is 8 inches long and 3 inches wide. How many pen-wipers can I make if I use 2 square inches in making 1?

LESSON IV.

1. Take your piece of paper and tear it in such a way as to make a rectangle 2 inches wide and 5 inches long.

2. On the upper side, one inch from the right hand corner, place a dot.

3. Draw a line from this dot to the lower right hand corner. What have you made to the right of the line?

4. Tear off the triangle.

5. On the lower side, 1 inch from the left hand corner, make a dot.

6. Draw a line from this dot to the upper left hand corner. Tear off the triangle.

7. Show me what you have left. Write its name. Why is it a —?

8. On the lower side, one inch from the right hand corner of the parallelogram, place a dot.

9. Draw a line from this dot to the upper right hand corner. Tear off the right triangle.

10. Place the triangle next to the left hand side of the parallelogram so that the oblique sides meet.

11. What have you made? Fill in the blanks. A parallelo-

gram can be seen as a —— with a base and ——, the same as the base and altitude of the ——.

12. The base of a parallelogram is 10 inches long and its altitude is 6 inches. What is its area?

13. The altitude of a parallelogram is 5 inches and its base is 20 inches. What is its area?

14. What is the area of a parallelogram with a base 9 inches long and an altitude of 3 inches?

15. A boy had a paper 12 inches long and 12 inches wide. What do we call such a shaped paper?

16. How many rows of square inches does it contain? How many square inches in a row? How many 12 square inches? How many square inches?

17. How many square inches make a square foot? How many square inches in a surface 1 foot square?

18. If sheet iron is worth 6 cents a square foot, what will a piece represented by Fig. K cost? Why? Is it a foot square? Is it a square foot?

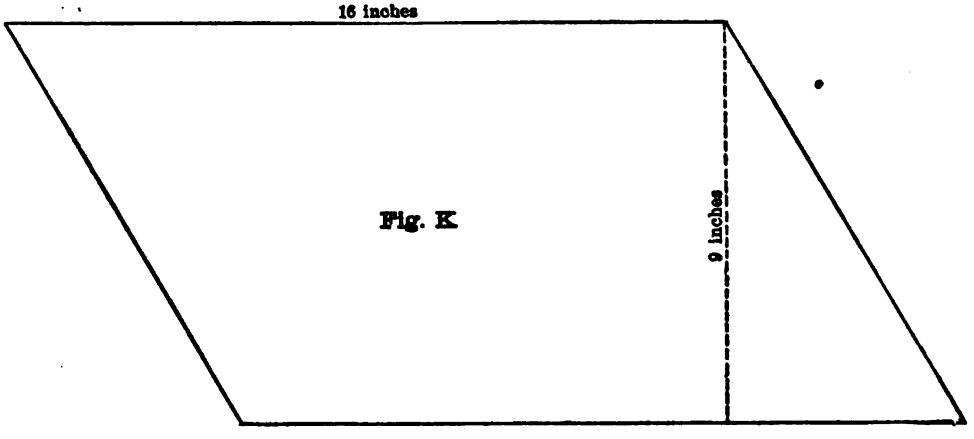


Fig. K

19. What is the difference between a foot square and a square foot?

20. What is the difference between a surface 2 feet square and 2 square feet?

21. Two square feet are what part of 2 feet square?

22. How many 2 square feet in 2 feet square? How many square feet?

23. One surface is 4 feet square and another contains 4 square feet. The second equals what part of the first?

SUGGESTIVE QUESTIONS ON CHART.

LESSON I.

1. See Fig. 52. It is a plan of a room. How many square feet on its floor? Find the answer in six different ways. I know seven ways to do it. Soon we can do it thirty ways.

2. See Fig. 53. It is the plan of a room drawn on a scale of $\frac{3}{4}$ of an inch to $5\frac{1}{3}$ feet. How many square feet in the four walls of the room, it being 10 feet high?

3. How many square feet in the ceiling of the room of which Fig. 53 is a plan? See Ex. 2 for the scale.

4. If we change the scale to $\frac{1}{16}$ of an inch to 1 foot, how many square feet on the four walls and ceiling?

5. How many feet long is a wall that is 12 feet high and contains 264 square feet?

6. A square rectangle contains 144 square feet. How long and wide is it?

7. A wall is 8 feet high, 156 feet are $\frac{39}{64}$ of its area. How long is the wall?

8. If 460 square feet are $\frac{5}{8}$ of the area of a wall, how many square feet does it contain?

9. If .8 of the area of a ceiling contains 680 square feet, how many square feet in the whole ceiling?

10. How long is a room that is 18 feet wide and 240 square feet are $\frac{2}{3}$ of its whole area?

11. $\frac{3}{4}$ of the square feet on the floor of a room equal 180 square feet. How many square feet on the floor?

12. 490 square feet are .7 of the square feet in the ceiling of a room 70 feet wide. How long is the room?

CHART

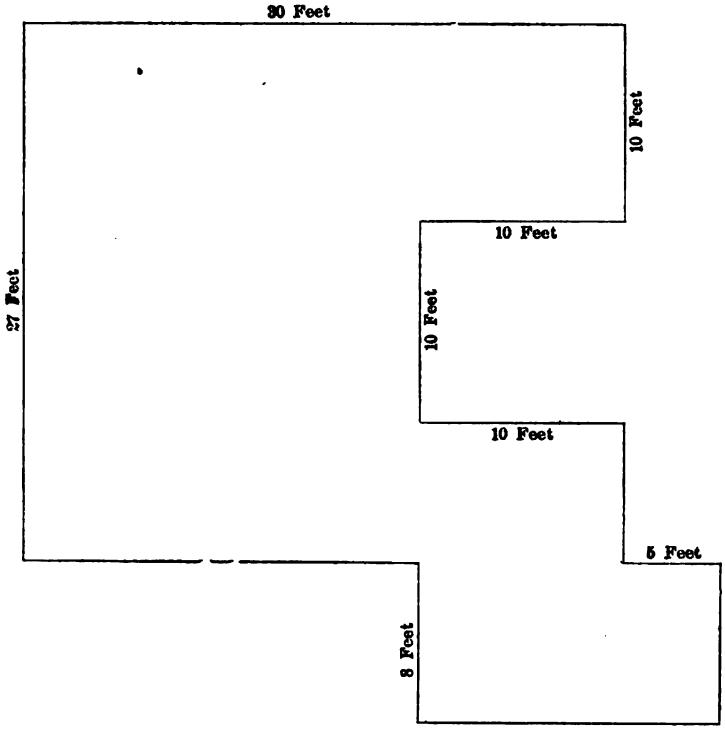


Fig. LII.

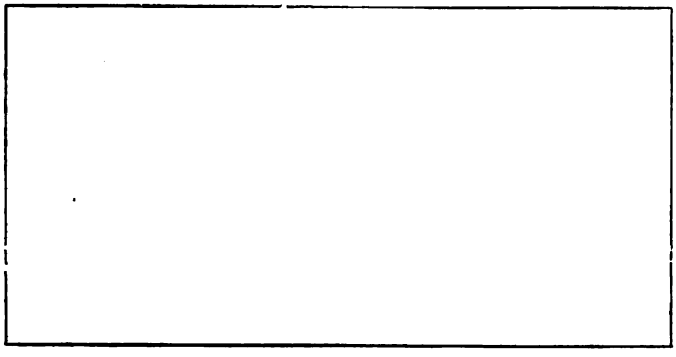


Fig. LIII.

SUGGESTIVE QUESTIONS ON CHART.

LESSON I.

NOTE.—The children should read and follow the directions as a study lesson.

1. Take a piece of paper 8 inches long and 6 inches wide. Hold it so as to make a cylinder 6 inches high, or I might have said whose altitude will be 6 inches.

2. What is the circumference of your cylinder? What is its altitude?

3. Change the cylinder to a rectangle. How long is the rectangle or what is the length of the base? How wide is it, or what is its altitude?

4. What is the area of the rectangle in square inches? Then what was the area of the convex surface of the cylinder?

5. Copy and fill in the blanks. A cylinder may be seen as a rectangle with a base equal ——— of the cylinder and an altitude ——————— cylinder.

6. See Fig. 54. What was the area of the convex surface of the cuff of which this is a cut made on a scale of $\frac{1}{4}$ inch to 1 inch?

7. What is the convex surface of the cylinder of which Fig. 55 is a cut?

NOTE.—The circumference of a cylinder or circle is $3\frac{1}{7}$ times its diameter, or so nearly $3\frac{1}{7}$, that it is practical to use it. Some people use 3.1416 times the diameter; this, however is not perfectly accurate. There are mathematicians who have carried the decimal 500 places and then were not absolutely correct, hence we will use $3\frac{1}{7}$.

8. The diameter of a cylinder was 21 inches and its height 40 inches, what was the area of its convex surface?

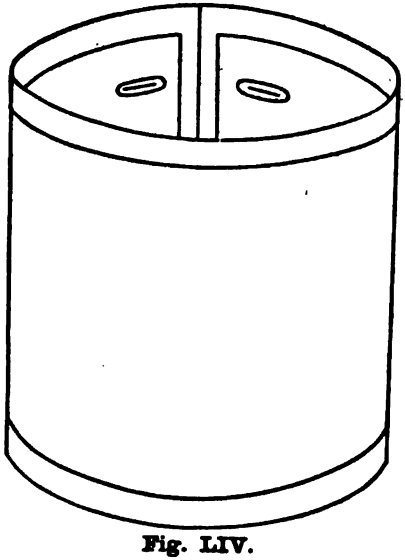


Fig. LIV.

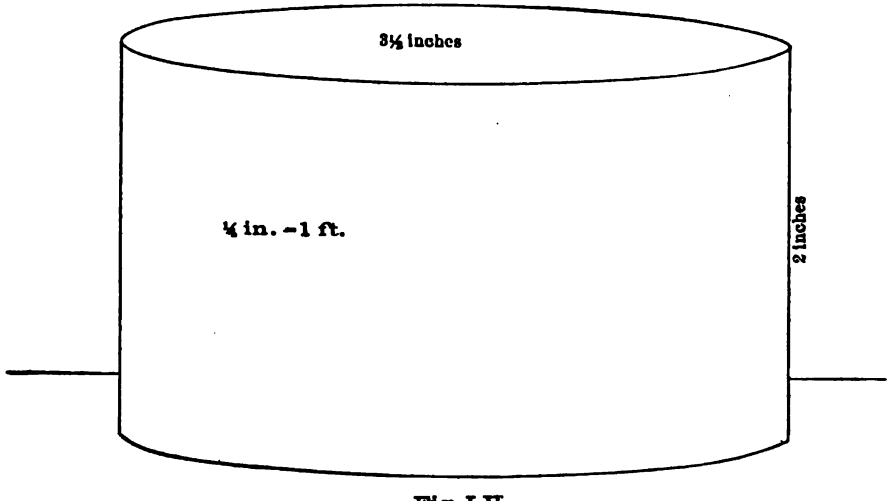


Fig. LV.

LESSON II.

9. I have a cylinder whose circumference is 22 inches and whose altitude is 15 inches. What is the area in square inches of its convex surface?

10. What is the area of the convex surface of a cylinder with a circumference of 44 inches and a height of 32 inches?

11. A stove pipe is 6 inches in diameter and 2 feet in length. How many square feet of sheet iron were used in making it, allowing 12 square inches for lapping at the joints?

12. If a stove pipe is 9 feet long and 6 inches in diameter, and no allowance is made for lapping, how many square feet of sheet iron were used in making it?

13. A cylinder is 8 feet in diameter, $25\frac{1}{7}$ feet in circumference and 10 feet high. How many square feet on its convex surface?

14. A column is 44 inches in circumference and 10 feet high. How many square *inches* on its convex surface?

READING LESSON III.

We are now ready to paper walls and ceilings of a room. In order that we may do this understandingly, I wrote a letter to a gentleman who is engaged in this business and asked him just how he would go to work to find the cost of papering a room, and he very kindly gave me the desired information. To get this information I asked him to answer a number of questions for me. I shall write my questions and the answer to each as he answered them for me.

DEAR SIR:—We are about taking up in our arithmetic work problems that relate to the subject of papering walls and ceilings. I desire to teach the subject in as practical and business like a manner as possible. That I may do so, will you kindly answer the following questions for me?

(1) "How wide is the cheapest wall paper?"

Answer.—"Eighteen inches."

(2) "Does the best quality vary in width?"

Answer.—"Yes, from eighteen inches to twenty-two inches, and from thirty to thirty-six inches."

(3) "How many yards are there in a single roll?"

Answer.—"In American paper, eight yards. In English paper, twelve yards."

(4) "How many yards in a double roll?"

Answer.—"Sixteen yards for American paper. English paper comes only in single rolls."

(5) "How do you estimate the cost of papering a room?"

Answer.—"By getting the number of square feet in the walls and ceiling. There are thirty-six square feet of covering surface in a roll of paper."

(6) "Do you deduct anything for windows and doors?"

Answer.—"Yes, generally allow twenty square feet to an opening."

(7) "How do you estimate the cost of borders and center-pieces?"

Answer.—"Borders according to the width, and center-pieces as agreed upon, according to size and quality."

(8) "Who pays for the waste?"

Answer.—"The purchaser. All paper must be hung to match."

You will notice that in the fifth answer the gentleman says there are thirty-six square feet of covering surface in a roll of paper. This, of course, refers to the cheapest paper or that which is eighteen inches wide. For if the roll is eight yards long it is twenty-four feet long. Then there are one and one-half rows of twenty-four square feet, or thirty-six square feet in the whole surface.

The paper that is twenty-two inches wide contains one and five-sixths rows of twenty-four square feet, or forty-four square feet.

When the rolls are thirty inches wide there are sixty square feet of covering surface in a roll, and when they are thirty-six inches wide there are seventy-two.

Now, let us apply our information. I have a room that is 20 by 24 feet. What will it cost to paper its walls with the cheapest paper

at 20 cents a roll? There are two windows and one door in the room, and we are to allow two-ninths of a roll for waste. The walls are 10 feet high.

(1) The four walls will make a rectangle 88 feet long and 10 feet high, giving us ten rows. Therefore, there are ten, 88 square feet, or 880 square feet.

From this we must take three, 20 square feet for the door and two windows. 880 – 60 equals 820 square feet.

Then it will take as many rolls as there are thirty-six square feet in 820 square feet, or $22\frac{7}{9}$ plus $\frac{2}{9}$ waste equals 23 rolls; at 20 cents per roll equals $4.60.

(2) I have a room 32 feet square. It is 7 feet high. There are two doors and three windows in it. If I allow two-thirds of a roll waste, what will it cost to have it papered at 60 cents a single roll on the wall? The paper to be 30 inches wide.

Here we have a rectangle 128 by 7 feet. Then there are seven, 128 square feet on the four walls, or 896 square feet.

The ceiling is a rectangle 32 by 32 feet, or thirty-two, 32 square feet, or 1024 square feet. 1024 and 896 square feet equal 1920 square feet. From this we take for the doors and windows 100 square feet, leaving 1820. It will take as many rolls as there are sixty square feet in 1820 square feet, or $30\frac{1}{3}$ plus $\frac{2}{3}$ waste, equal 31 rolls; at 60 cents a roll, equals $18.60 Ans.

WRITTEN WORK.

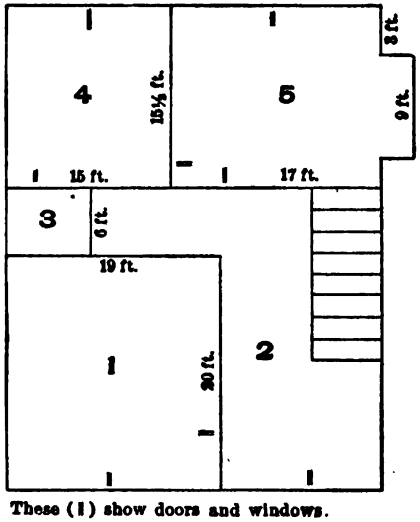
1. See Fig. O. It is the first floor plan of a house. Room 1 is the parlor; 2, the hall; 3, a pantry; 4, the kitchen; 5, the dining-room.

2. The kitchen (room 4) is 8 feet high; I desire to paper it with 18-inch paper. How many rolls of paper must I buy (always single rolls unless the kind is mentioned), allowing $\frac{1}{9}$ roll for waste? Do not forget the door and the windows.

3. What will it cost to paper the parlor (room 1) with 30-inch

paper, at 80 cents a roll, on the wall, allowing nothing for waste? The room is 10 feet high.

4. What would the ceiling cost, if first papered, and then a $2.60 center piece be added? There was $\frac{3}{5}$ of a roll waste.



These (I) show doors and windows.

Fig. O.

5. At 40 cents a roll on the wall, what will it cost to paper the dining-room (room 5) with 18 inch paper, the ceiling being 10 feet high? The bay window being left out of the estimate.

6. A room is 8 feet high and 20 feet square. How many rolls of paper will it take to paper it?

7. How many rolls of paper will it take to paper the walls of a room 16 by 18, if it is 9 feet high?

8. A room is 12 feet square and 7 feet high. How many rolls of paper will it take to paper its four walls and ceiling?

CHART XXV.

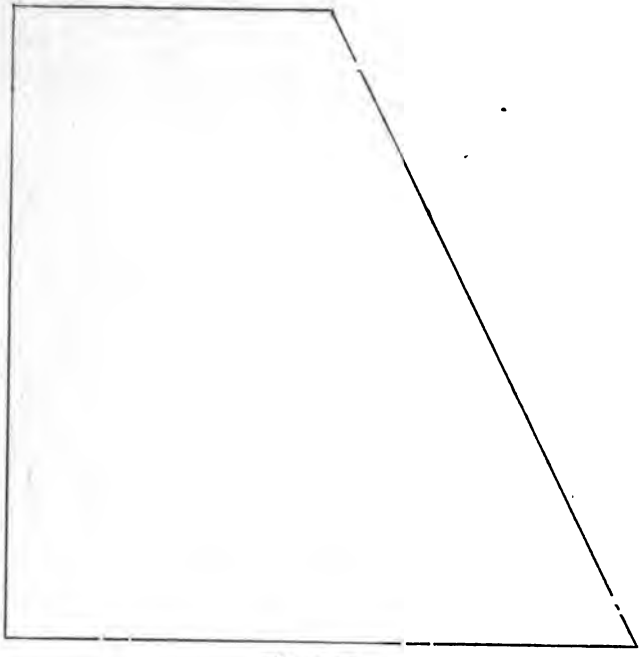


Fig. LVI.

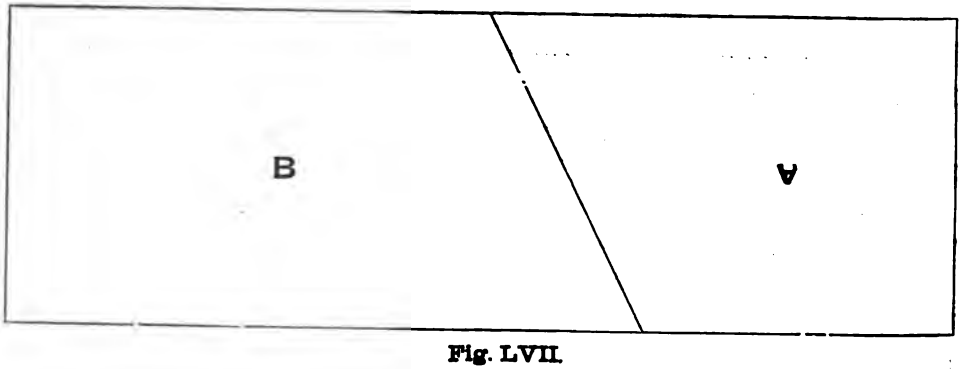


Fig. LVII.

CHART XXV.

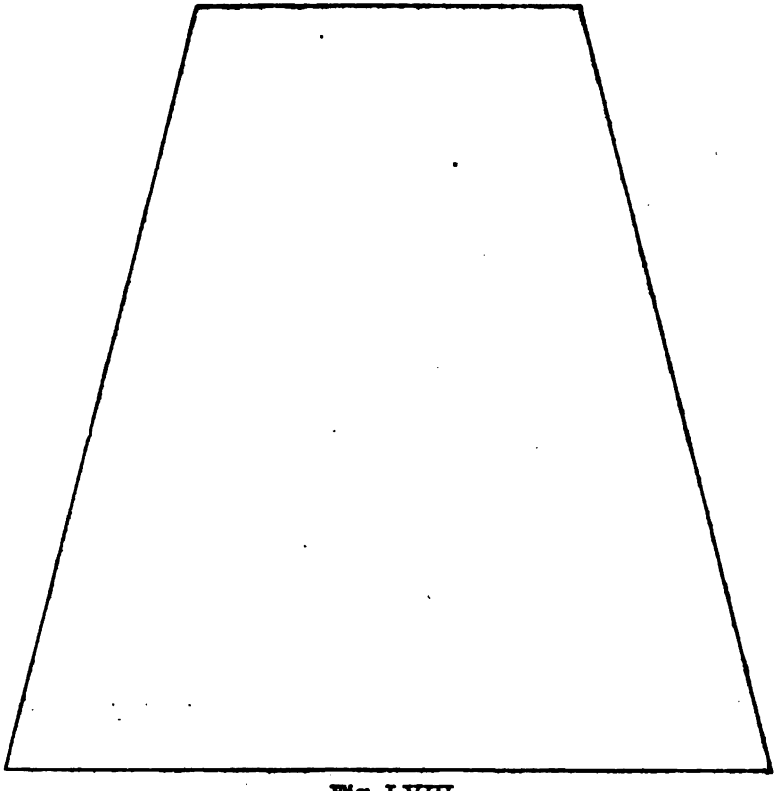


Fig. LVIII.

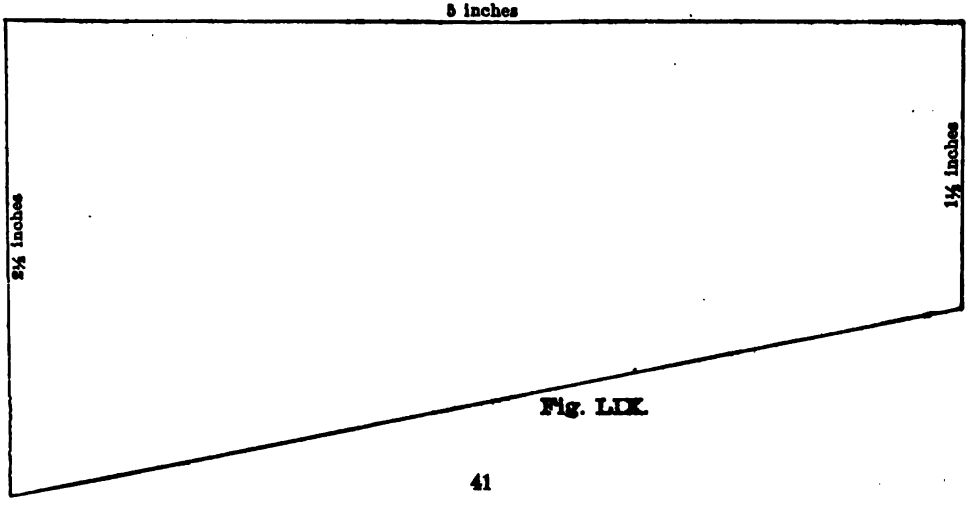


Fig. LIX.

SUGGESTIVE QUESTIONS ON CHART XXV.

1. You may cut out a 4 inch square. On the upper side, 2 inches from the upper left hand corner, make a point. Place your ruler on this point and the lower right hand corner. Tear off the piece on the right side of your ruler.

2. Hold up the four-sided piece. What do we call such a figure? What is a trapezoid?

3. Place your trapezoid by that shown on Chart XXV., Fig. 56. It should be like it. How many find that it is? Hands up.

4. Fold your paper so that the parallel sides will meet. Crease and open. Mark the upper part A and the lower part B.

5. Tear off A. Place it by the side of B so that the oblique sides will meet and A will be up side down.

6. What have you made? Compare the rectangle with the trapezoid. How long is its base? How long is its altitude? How long was the altitude of the trapezoid? See if your rectangle will cover Fig. 57.

7. Copy and fill in the blanks. A trapezoid may be seen as a rectangle with a base equal to the sum — — — — — — trapezoid and an altitude equal — — — — — trapezoid.

8. Make a trapezoid that will just cover Fig. 58 on Chart XXV.

9. Cut *this* so that it will make a rectangle with a base equal to the sum of the parallel sides and an altitude equal to one-half the altitude of the trapezoid.

10. What is the area of Fig. 59?

SUGGESTIVE QUESTIONS ON CHART XXVI.

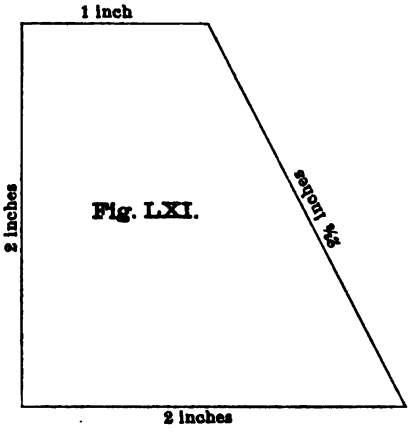
LESSON I.

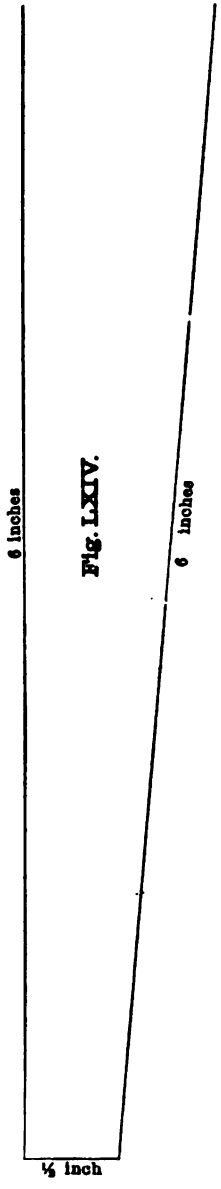
1. What will be the dimensions of the rectangle that can be made of Fig. 60?

2. What will be the altitude and base of the rectangle that can be made of Fig. 61?

3. Fig. 62 will make a rectangle how wide and long?

CHART XXVI.


1 inch
2 inches
Fig. LXI.
2 inches


6 inches
Fig. LXIV.
6 inches
⅛ inch

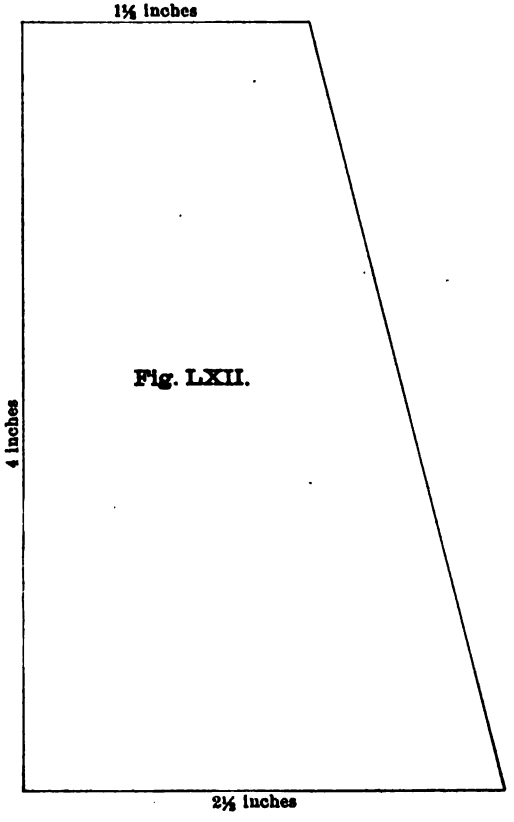

1⅛ inches
Fig. LXII.
4 inches
2⅛ inches

CHART XXVI.
Continued

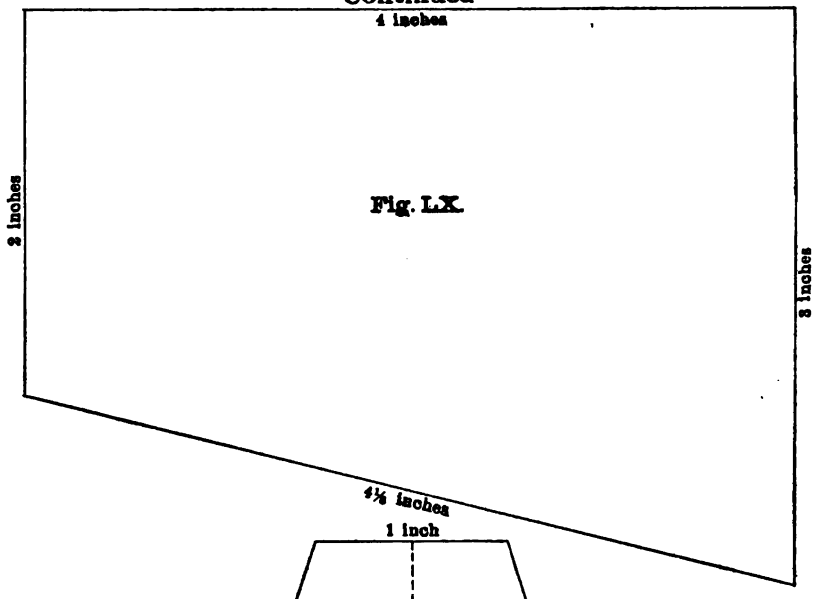


Fig. LX.

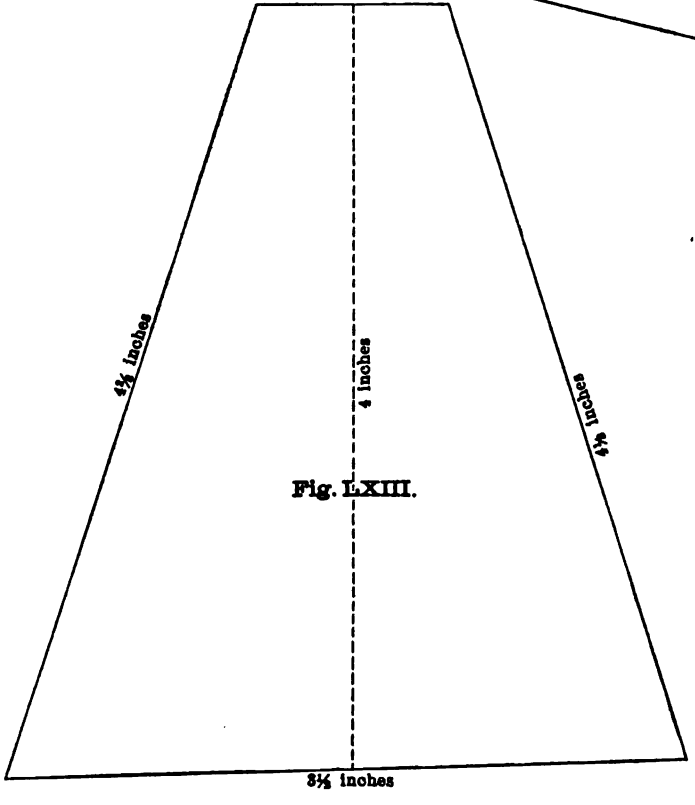


Fig. LXIII.

4. How wide and long a rectangle can be made of Fig. 63?

5. What will be the width and length of the rectangle that can be made with Fig. 64?

6. Find the area of Fig. 60. What part of a square foot is its area?

7. Find the area of Fig. 61. Its area is equal to what part of the area of Fig. 60?

LESSON II.

1. What is the area of Fig. 62? Fig. 61's area equals what part of 62's? Sixty-two's area equals what part of 60's?

2. What is the area of Fig. 63? Fig. 61 is equal to what part of the area of Fig. 63? Fig. 62 equals what part of the area of Fig. 63? Fig. 63 equals what part of the area of Fig. 60?

3. How many square inches in Fig. 64?

4. Fig. 61 is equal to what part of Fig. 64?

5. Fig. 64 is equal to what part of Fig. 60? Of Fig. 63?

6. Fig. 64 is equal to what part of Fig. 62?

7. How many 5 square inches in the sum of all the figures on Chart XXVI.? How many 3 square inches?

8. How many half-inch squares in Fig. 63? Fig. 62?

READING LESSON IV.

1. If required to find how many square inches on the four sides of a box 5 inches long, 4 inches wide and 10 inches deep, I should think of a rectangle having 10 rows containing 18 square inches each.

2. If required to find how many square feet on the four walls of a room 5 feet long, 4 feet wide and 10 feet high, I should think of a rectangle having — rows containing — square —— each, or —— square feet.

3. If required to find how many square feet on the convex surface of a cylinder 28 feet in circumference and 20 feet high, I should think of a rectangle having — rows containing — square feet each.

4. If asked to find the square feet in the four walls of a hall 3 feet wide, 15 feet long and 10 feet high, I should think of a rectangle having — rows containing — square feet each, or —— square feet.

5. To find the area of a trapezoid with one parallel side 6 feet long and the other 14 feet long and an altitude 20 feet high, we think of a rectangle containing — rows of — square feet each, or —— square feet.

6. To find the area of a triangle with an altitude 12 feet high and a base 20 feet long, we think of a rectangle having — rows of — square feet each, or —— square feet.

7. To find the number of square feet on the four walls of a room 12 feet square and 10 feet high, we think of a rectangle having — rows containing — square feet each, or —— square feet.

8. One foot square contains — rows, each containing — square inches, or —— square inches in one square foot.

9. A yard square contains — rows, each containing — square feet, or —— square feet in one square yard.

10. To find the number of square yards in the four walls of a room 9 feet square and 10 feet high, we think of a rectangle having 10 rows of 36 square feet, or 360 square feet. Since there are 9 square feet in one square yard, there will be as many square yards in 360 square feet as there are 9 square feet in 360 square feet, which are 40 (nine square feet); hence 40 square yards.

WRITTEN WORK.

1. How many square yards in the four walls of a room 12 feet square and 8 feet high?

2. A room is 12 feet wide, 16 feet long, and 9 feet high. How many square yards in its four walls?

3. How many square yards in the ceiling of the room described in example 2? How many square yards in its four walls and ceiling?

4. At 20c. per square yard, what will it cost to lath and plaster a room 24 feet long, 22 feet wide and 9 feet high?

5. Some men allow for openings in the wall. What would have been the answer to problem 5 had there been an allowance of 10% or 38 square feet?

6. The northern boundary line of a lawn began at a point A and ran due east 30 feet to a point B; from point B due south 24 feet to a point C; from point C due west 40 feet to a point D; from point D northeast to place of beginning. What will it cost to sod the lawn at 36c. per square yard?

7. At 36c. per square yard, what will it cost to sod a strip of lawn described as follows: The eastern boundary began at point A and ran due south 20 feet to point B; from point B due west 18 feet to point C and from C northeast to the place of beginning?

8. How many square yards of cloth will it take to cover a column that is 14 feet high and $18\frac{1}{7}$ feet in circumference?

9. A cylindrical cistern is 8 feet deep and 7 feet in diameter. What will it cost to plaster its sides at 40c. per square yard? (If 7 feet in diameter it must be 22 feet in circumference. Why?)

READING LESSON V.

Not long ago, we took our class to the play ground. Some of them had a surveyor's chain, while others had a string sixty-six feet long. On the north side of the ground, we began at a given point, and measured in a straight line west from that point five chains. Beginning at the same point we again measured in a straight line south two chains. From this second point we measured in a straight line west five chains. Then we measured from one of the western points to the other and found the distance to be two chains. We all met at the north-east point, and walked around the boundary lines of the piece of land measured. Then beginning at the north-east corner once more, we measured west again one chain. From

this point we measured one chain south; then from this point one chain east was measured.

Below we give a plan of the lot measured off. It is drawn on a scale of one inch to a chain. (See Fig. K.) This was drawn on the blackboard, our scale there being one foot to a chain. The class was then questioned as follows:

"Of what is this a plan, Emma?"

"It is the plan of our lot."

"What is this, Gertrude?"

"It is the square chain."

"How many rods long is it, Jennie?"

"It is four rods long."

"Then it contains how many square rods, John?"

"It contains sixteen square rods."

"How many square rods in an acre, May?"

"One hundred and sixty square rods."

"What part of an acre, May?"

"One-tenth of an acre."

"Then a square chain equals?"

"One-tenth acre."

"How many of these square chains in the first row?"

"Five."

"And how many rows?"

"Two."

"Hence, Roy?"

"Hence, there are ten square chains, or ten tenth acres or one acre."

"I have a lot four by five chains. How many acres in it, William?"

"There are four rows of five square chains, or twenty square chains, which equal two acres."

"B has a lot 24 by 36 rods. How many acres has he?"

"Twenty-four by thirty-six rods, or six by nine chains; hence, six rows of nine square chains, or fifty-four square chains, or 5.4 acres."

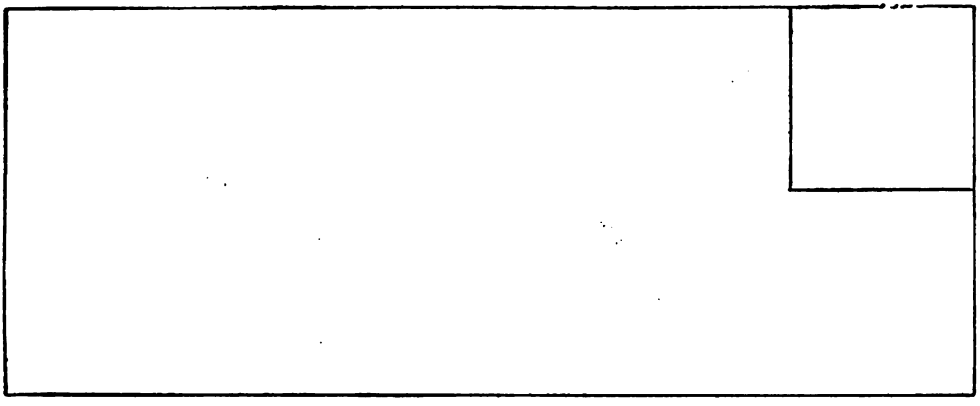
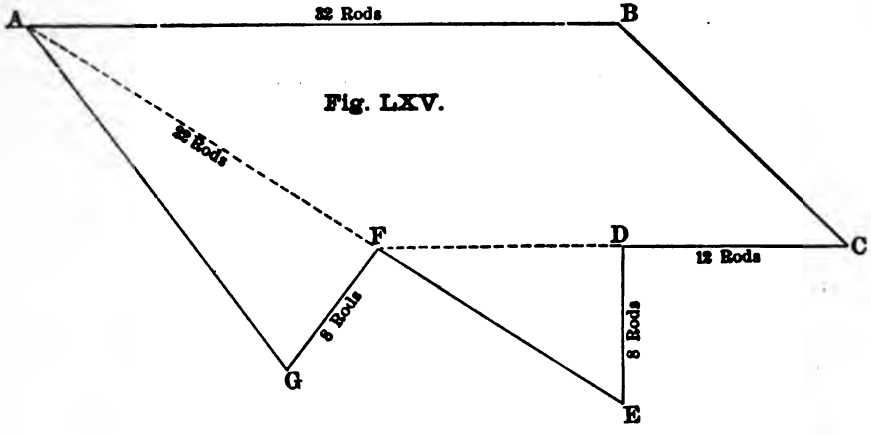


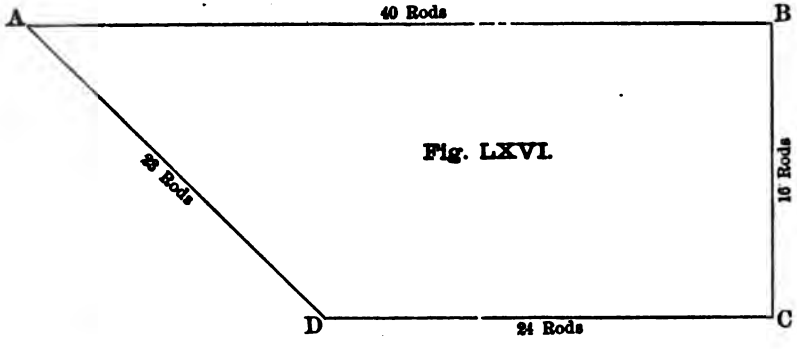
Fig. K.

NOTE.—Let the pupils now work the following problems without pencils.

1. How many acres in a lot 20 rods by 16 rods?
2. I have a piece of land 10 chains long and 2 chains wide. How many acres do you see?
3. If my lot is 20 chains long and 1 chain wide, how many acres do you see?
4. A garden is 6 chains long and 5 chains wide. How many acres does it contain?
5. A building lot is 1 chain wide and 2 chains deep. What is it worth at $800 per acre?
6. Mr. Small has a lot 20 rods by 24 rods. How many acres in it?
7. Mr. Williams has a lot 28 rods by 32 rods. How many acres has he?
8. Mr. White has a lot 66 feet by 132 feet. How many dollars is it worth at $1,200 per acre?

CHART XXVII.


A
32 Rods
B
Fig. LXV.
25 Rods
F
D
C
12 Rods
8 Rods
8 Rods
G
E


A
40 Rods
B
Fig. LXVI.
25 Rods
16 Rods
D
24 Rods
C

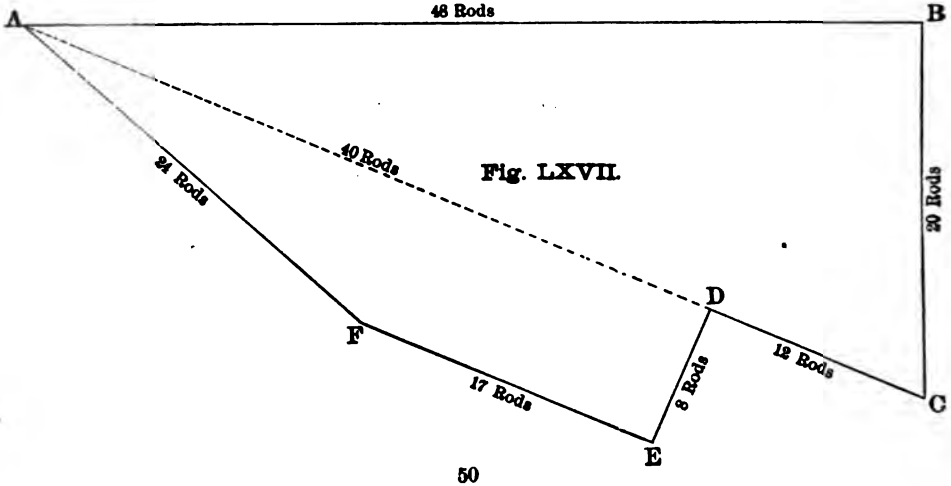

A
48 Rods
B
40 Rods
Fig. LXVII.
24 Rods
20 Rods
D
F
12 Rods
17 Rods
8 Rods
E
C

CHART XXVIII.

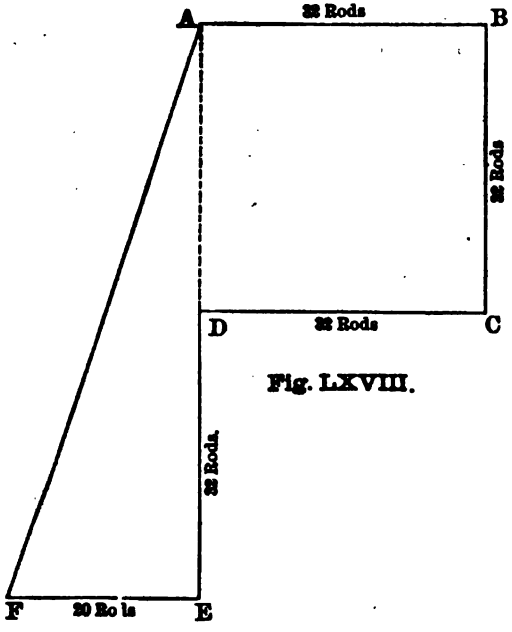


Fig. LXVIII.

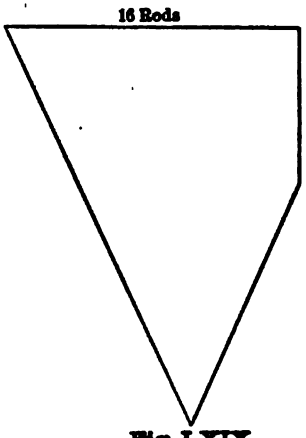


Fig. LXIX.

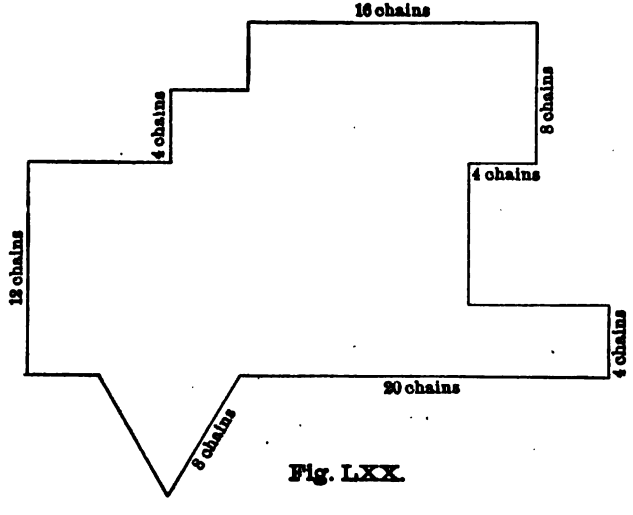


Fig. LXX.

SEE CHART XXVII.

1. Figs. 65, 66 and 67 are the maps of small farms owned by A, B and C. Judge who has the largest farm, A (Fig. 65), B (Fig. 66) or C (Fig. 67).
2. How many acres in A's farm?
3. How many acres in B's farm?
4. How many acres in C's farm?
5. How many acres in all the farms?
6. How many more in B's than in A's?

NOTE—Fig. 69. Make a dotted line forming a trapezoid with an altitude 8 rods, and a triangle with a base 12 rods and altitude 13 rods.

SEE CHART XXVIII.

1. Fig. 68 shows a piece of land worth $50 an acre. How much money will it take to buy it?
2. See Fig. 69. What is this lot worth at $100 per acre? (See Note.)
3. At $100 per acre lot Fig. 70 is worth how much more than lot 69? (Call the altitude of the triangle 6½ chs.)

SEE CHART XXIX.

1. What will it cost to sod a lot like Fig. 71 at 36c. a square yard? What part of an acre is this lot?
2. Mr. Smith owned a lot (see Fig. 72). After reserving plot B for himself, he sold the remainder of the land at $80 an acre. How much did he receive for the part sold? (Scale, $\frac{1}{4}$ inch to a rod.)
3. The part reserved was what part of the whole lot?

NOTE.—Take a piece of paper 7 by 9 inches. Fold one of the long sides so as to lap 3 inches. Crease and open. Fold the other long side so as to lap 3 inches. Crease and open. Hold up the paper so that the open edges will meet. What have you made? Change the triangular prism to a rectangle. Compare the rectangle with the prism. A triangular prism may be changed to a rectangle with a base equal to the sum of the — — of the prism and an altitude the — — — — — prism.

CHART XXIX.

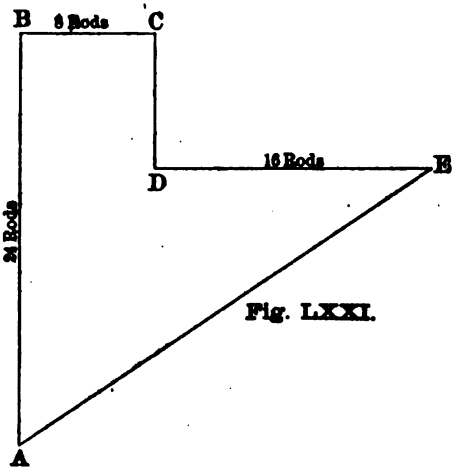


Fig. LXXI.

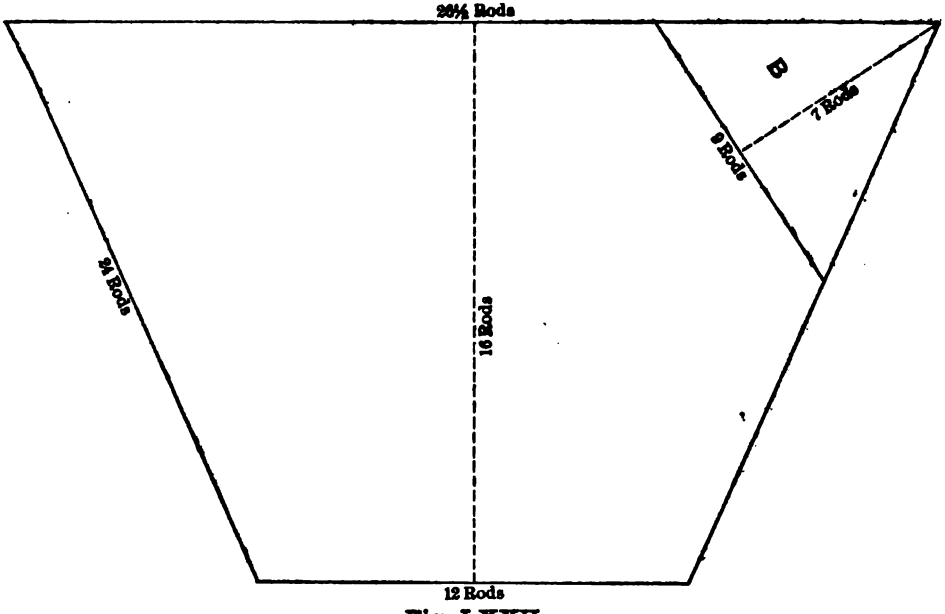


Fig. LXXII.

SUGGESTIVE QUESTIONS ON CHART XXX.

1. Take a piece of paper 5 by 6 inches; fold the paper so that the long edges will meet; crease and do not open.

2. Fold so that the short edges will meet; crease and do not open.

3. Fold so that the *uncut edges* will meet; crease and do not open. How many of you have your paper folded like Fig. 73, Chart XXX?

4. On the right vertical side lay off 2 inches, see *a b* Fig. 73. On the left oblique side lay off 2 inches, see *c b*. Find the center point between *a c*, see *d*. Now lay off 2 inches (*b e*) in line with *d*, draw a curve line, *c e a*.

5. Cut through the line *c e a*. Open your paper, what have you made? How is it divided? See Fig. 74, Chart XXX. The circle is not so large, but is divided into eighths the same as yours.

6. Cut the circle into eighths and place them the same as shown in Fig. 75. Divide one of the eighths into halves and place one piece on each end. What have you made?

7. Copy and fill in the blanks. A circle may be seen as a rectangle with a base equal to — — — — of the circle and an altitude equal to — — — of the circle.

NOTE —Were the circle divided into thousandths instead of eighths the curve line in the base would not be perceptible. Hence we may take no notice of it.

8. A circle 7 inches in diameter (remember $3\frac{1}{7}$ times the diameter equals the circumference) may be seen as a rectangle —— inches long and —— inches wide.

9. A rectangle made from a circle 14 inches in diameter and 44 inches in circumference will contain —— rows of —— square inches each.

10 What is the area, in square inches, of a circle 21 inches in diameter?

CHART XXX.

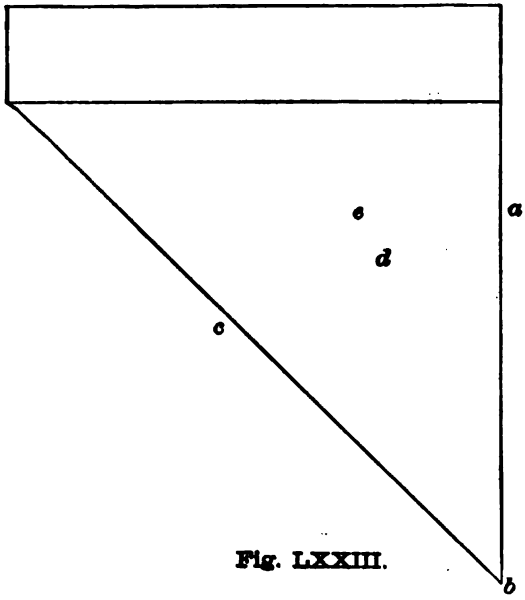


Fig. LXXIII.

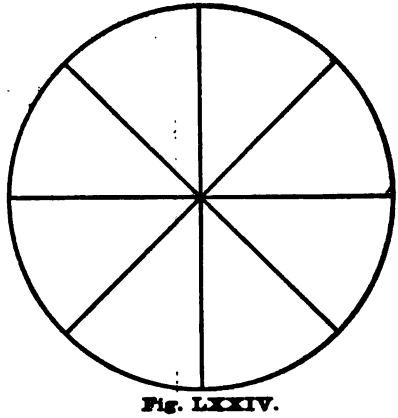


Fig. LXXIV.

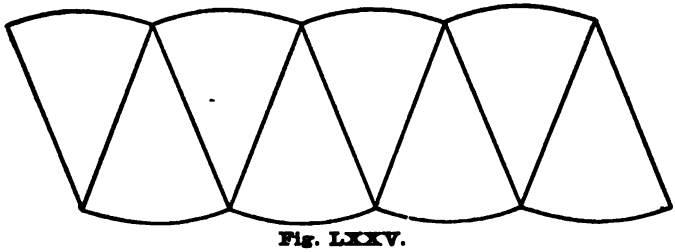


Fig. LXXV.

11. A circle 8 inches in diameter will make a rectangle how long and wide?

12. If a circle is 6 inches in diameter, what will be the width and length of a rectangle which may be seen?

13. John had a circle 28 inches in diameter. How many square inches did it contain?

14. The circumference of a circle was 66 feet. What was its diameter?

15. The circumference of a circle was 44 feet. What was its diameter?

CHART XXXI.

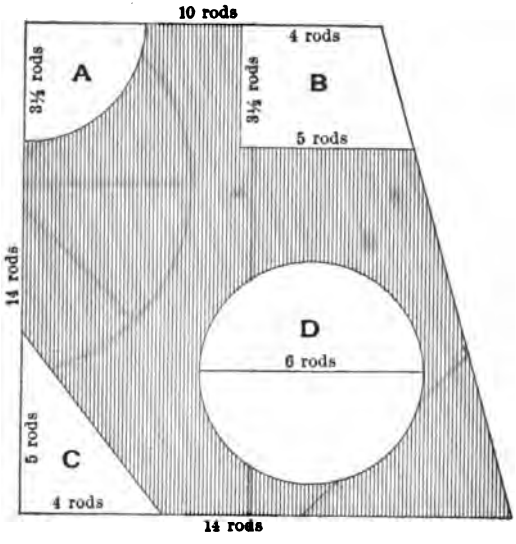


Fig. LXXVI.

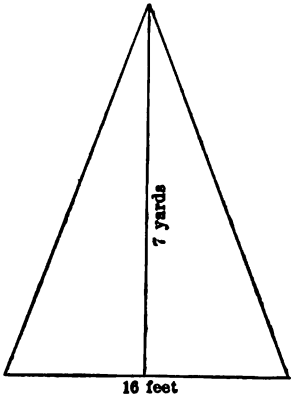


Fig. F.

16. What was the diameter of a circle that was 132 feet in circumference?

17. What is the area of Fig. 74?

18. What is the area of a figure with a diameter six times as long as that of Fig. 74?

SUGGESTIVE QUESTIONS ON CHART XXXI.

1. Fig. 76 is a lawn. A, B and C are flower beds. D is a fountain. The rest of the lawn is green grass. What did it cost to sod the lawn at $1.25 per square rod?

2. What is the area of a flower bed represented by Fig. F?

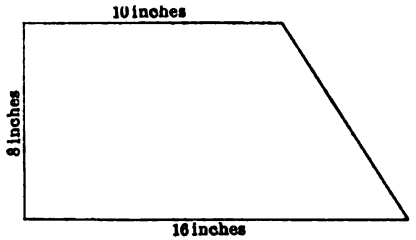
3. How does the area of Fig. F compare with the whole area of Fig. 76?

4. How many more square rods in the area of bed D than in bed B?

5. How many more square rods in B's area than in A's?

6. How many more square rods in C's area than in A's?

7. Fig. C's area is equal to how many F's?



FOLIO

Fig. B.

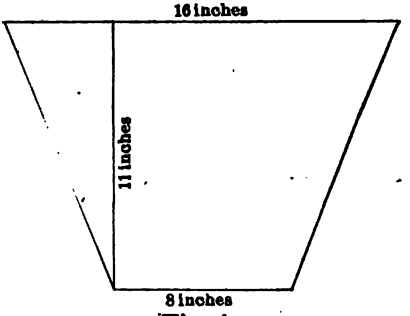


Fig. A.

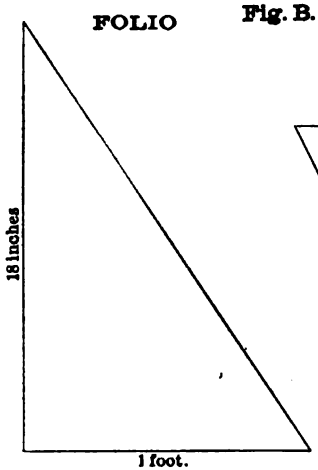


Fig. C.

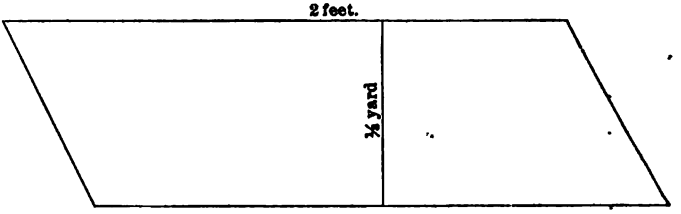


Fig. D.

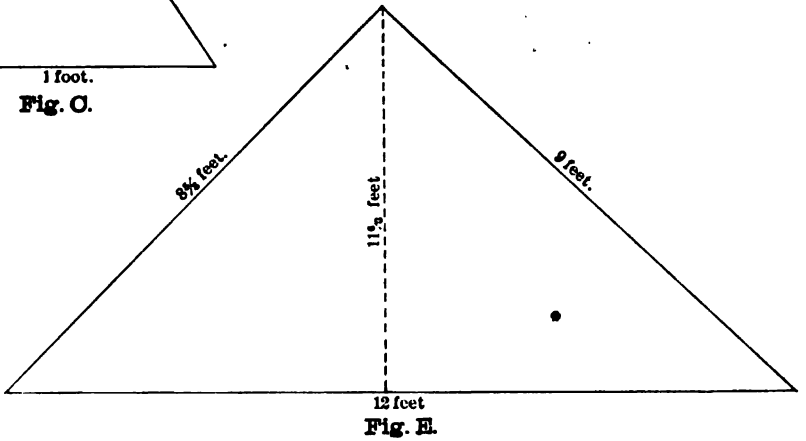


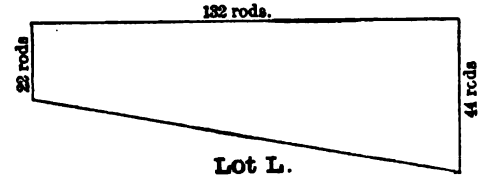
Fig. E.

1. How many square inches on the surface of a piece of paper the size and shape represented by Fig. C?

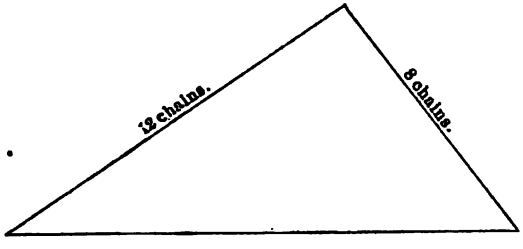
2. See Fig. D. If this were a board the size and shape as shown in the cut, how many square feet would there be on its surface?

3. Fig. E is the plan of a room. How many square feet in its ceiling?

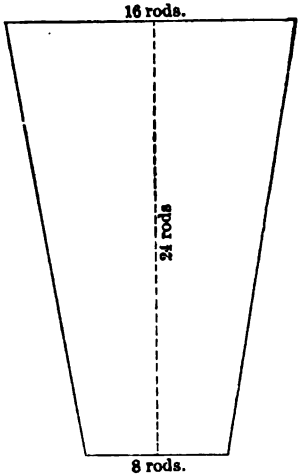
4. How many square inches on the surface of a card board the size and shape represented by Fig. A?



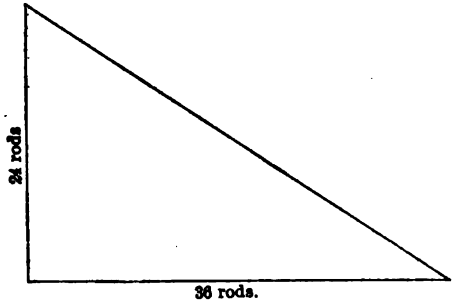
Lot L.



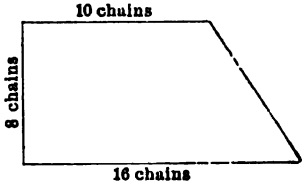
Lot O.



Lot N.



Lot M.



Lot P

5. I had a board the size and shape represented by Fig. B. How many square inches of paper will it take to cover it?

6. How many acres in Lot L?

7. How many acres in Lot O?

8. What is Lot M worth at $1,000 per acre?

9. What must I pay for Lot N at $800 per acre? How much for Lot P?

CHART XXXII.

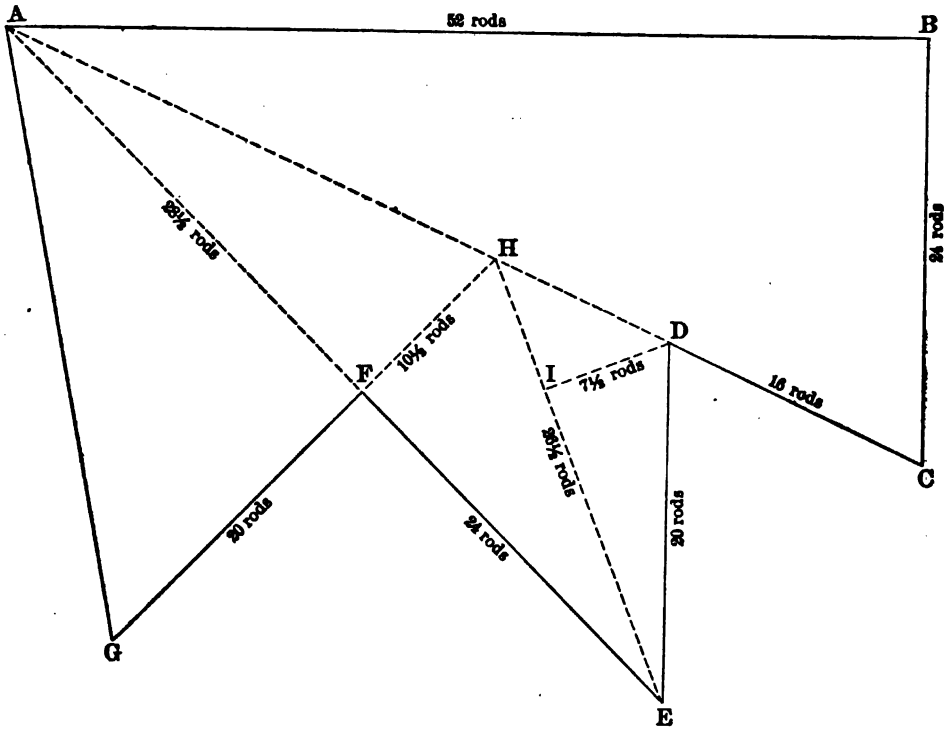


Fig. LXXVII.

SUGGESTIVE QUESTIONS ON CHART XXXII.

1. See Fig. 77. It is the map of a small farm along the lake shore. How many acres in the peninsula on the south side of the farm, calling the northern boundary line F H D?
2. How many acres in the whole farm?
3. The farm sold for $321; what was that an acre?
4. What was the peninsula worth at $40 an acre?
5. Had there been no lake on the south side, a line, running due east from G and meeting the line B C extended south 11 rods, would have been 46½ rods long. How many more acres of land would there have been in the farm?

NOTE.—The answer is so near 2.75 we may call it so. In deeds, as a rule, the fraction "hundredths" only is mentioned. Thus it would read 2 and .75 acres, more or less, etc.

WRITTEN WORK.

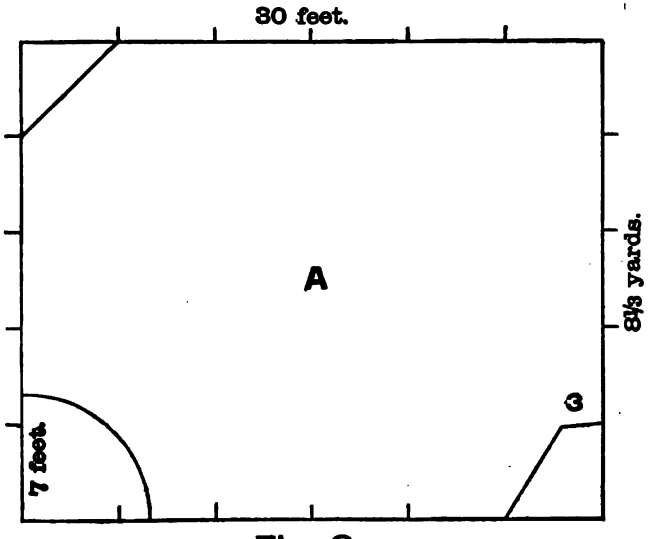


Fig. G.

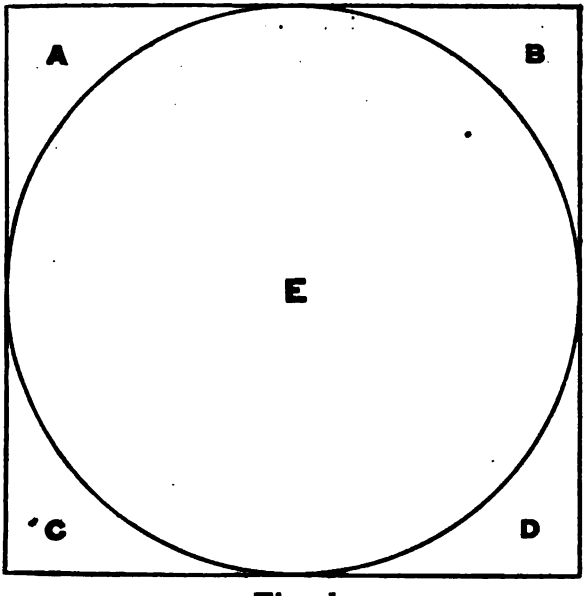


Fig. I.

1. Fig. G is the plan of a room in a house nearly eighty years old. How many square feet in the part marked A in the plan?

2. The area of the triangle is equal to what part of the trapezoid's area?

3. To what part of the quadrant's area is the area of the triangle equal?

4. Look at Fig. I. Which represents a 21-foot square? E is a fountain. Can any one tell me how much it would cost to sod B at 4c. per square foot? Then how much for A, B, C and D?

5. If the diameter of I was 42 feet, what would be the area of B? Doubling the diameter, then, made the area how many times greater? Who sees why this is always true?

WRITTEN WORK—LESSON II.

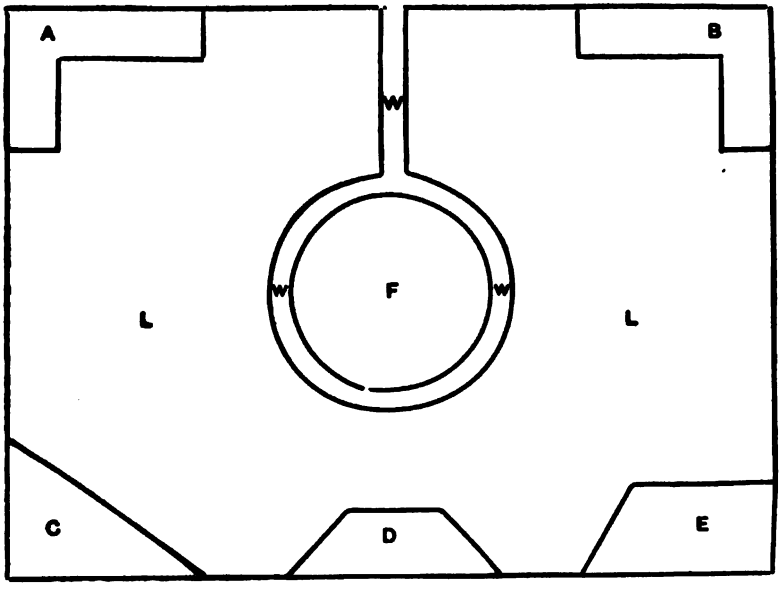


Fig. T.

Fig. T is the plan of a lot which was laid out as a garden. A, B, C, D and E are flower beds. The inner circle F is an artificial lake. W, W, W is a gravel walk extending from the entrance to the lake, and, as you see, passing around the lake. The remaining space is a lawn. Scale ¼ inch = 5 feet.

1. How many square feet in the lawn?
2. In each flower bed?

3. In the walk?
4. On the surface of the lake?
5. In the entire lot?

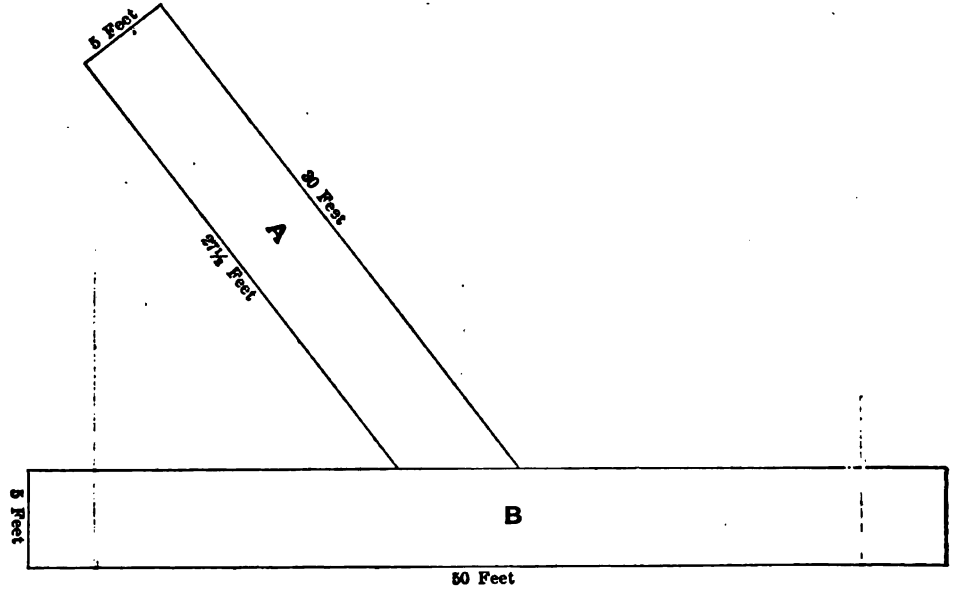


Fig. U.

6. See Fig. U. How much will it cost to build this walk at 30c. per square yard?

7. What is that part of the walk marked A? What is the part marked B? Why is A a trapezoid? Why is B a rectangle?

8. A roof (See Fig. IX) is 20 feet long and 10 feet wide. How many square feet does it contain?

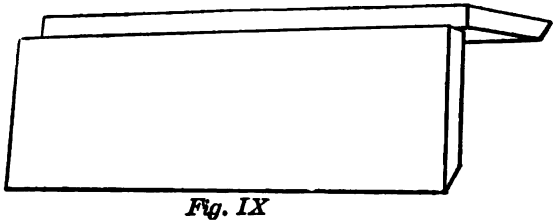


Fig. IX

NOTE.—We see a rectangle that is 20 by 20 feet, or 20 rows of 20 square feet (See Fig. X).

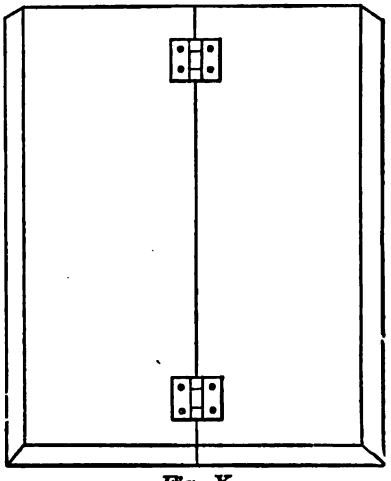


Fig. X

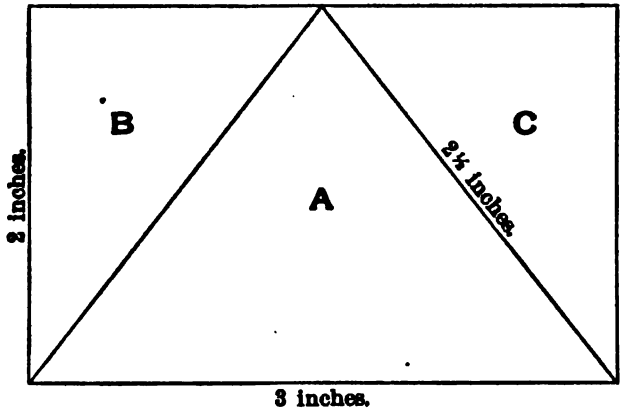
9. The roof of a house is 20 feet long with a pitch of 10 feet. How many shingles will be required to shingle it if 1,000 shingles cover 100 square feet? How many bunches will that be? (Find out at home.)

WRITTEN WORK. LESSON III.

1. How many square inches in A? In B? In B and C together?
2. B equals what part of A? How many Bs in A?
3. If A, B and C are drawn on a scale of $\frac{1}{4}$ inch to a foot, how many square feet in each?

4. If the scale is ½ inch to 15 chains, how many acres does each contain? How many miles around A? B?

5. I have a piece of glass 3 feet square and cut out a piece of glass 1 foot square. How many square feet of glass shall I have left?



SUGGESTIVE QUESTIONS ON CHART XXXIII.

1. Find the area of Fig. 78 in two ways.
2. Triangle A is what part of the whole area?
3. To what part of B's area is the area of triangle A equal?
4. Triangle B is what part of the whole area?
5. Triangles A and B are what part of the whole area?
6. See Fig. 79. It shows how Mr. Brown's farm looked after being cut up by railroads. How many acres did the Great Eastern R. R. take? How many in the lot between D and B?
7. If the land was worth $80 an acre, how much would 5.16 acres be worth?
8. What would lot A be worth at $80 an acre?
9. What would lot D be worth at $60 an acre?
10. Mr. Brown planted potatoes in lot C. He had an average of 10 bushels to the acre. How many bushels did he have?

CHART XXXIII.

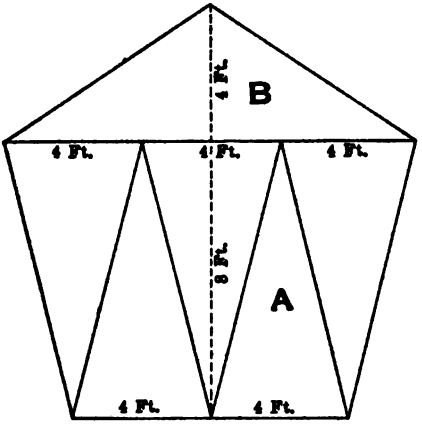


Fig. LXXVIII.

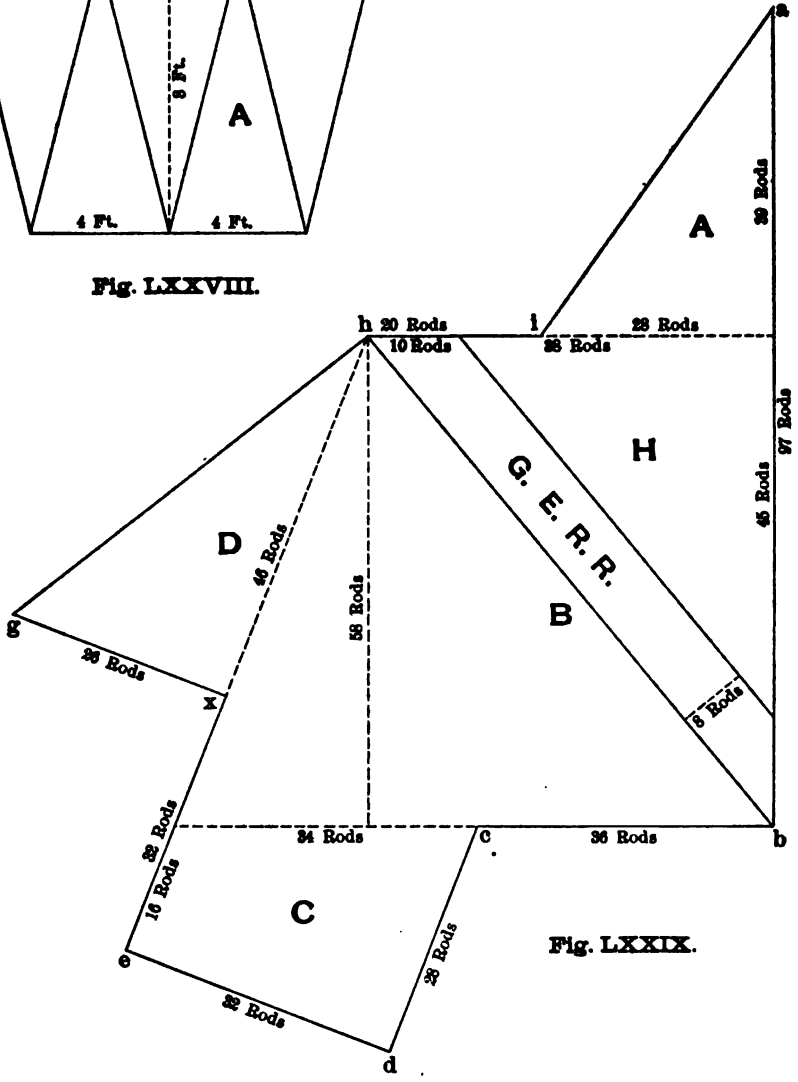


Fig. LXXIX.

THE OCTAGON.

1. Fold a paper 5 by 6 inches the same as you did for the circle. See Chart XXX. Draw a line from A to C. Cut through this line. Open your paper. How many have a figure like Fig. X? Make a rectangle of it. Compare the rectangle with the octagon. What is the area of X?

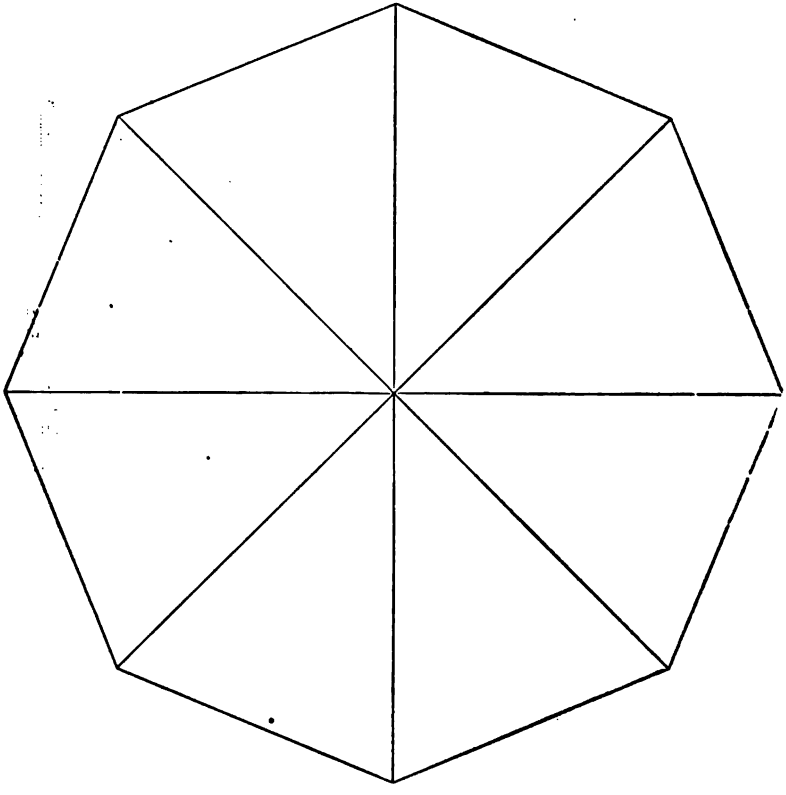
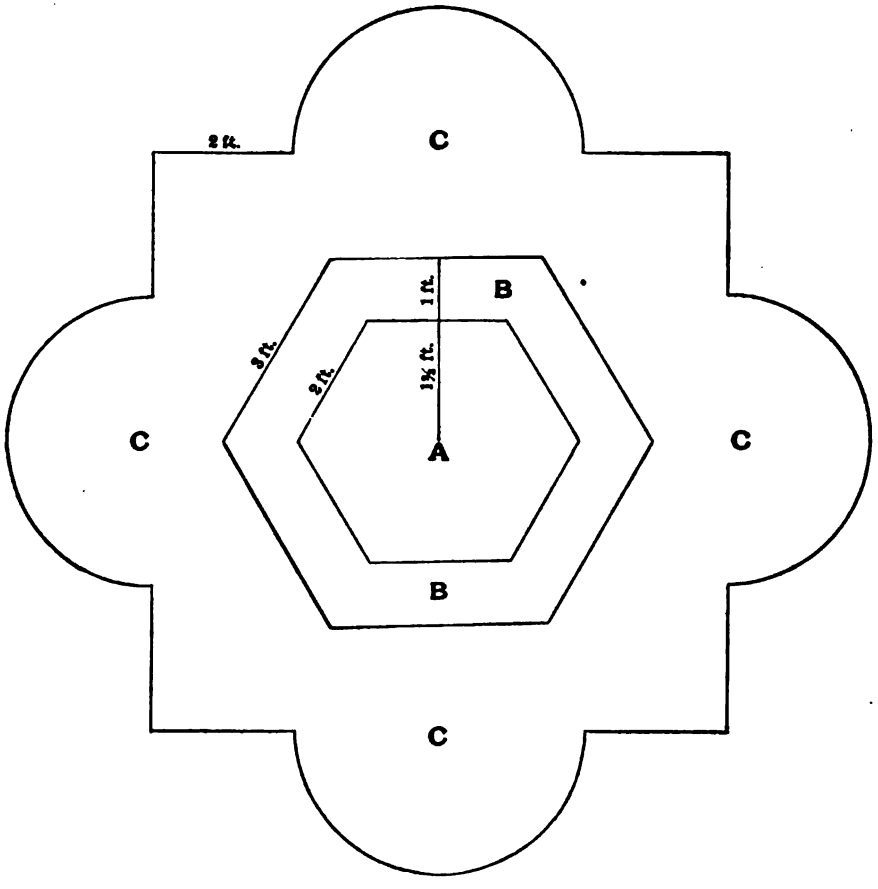


Fig. X.

What is the area of X?



2. Find the area of the part marked A. (Scale $\frac{3}{8}$ in. to ft.)
3. A's area is $\frac{5}{7}$ of B's. Then what is B's area?
4. Prove your answer to be right.
5. What is the area of the part marked C?
6. 64 square feet equal $\frac{56}{57}$ of C's area. Does this agree with your answer?

INTERESTING FACTS IN GEOGRAPHY.

NAME OF COUNTRY.	AREA IN SQUARE MILES.
The Dominion of Canada	3,470,257
Labrador	420,000
Newfoundland	40,200
United States	3,025,600
Mexico	742,148
Central America	172,925

1. How many square miles in the area of North America, exclusive of Alaska?
2. How much larger is Canada than the United States?
3. The United States are how much larger than Mexico?
4. Mexico is how much larger than Labrador?
5. How much larger is Central America than Newfoundland?
6. To how many Mexicos are the United States equal?

NOTE.—These are but a few of the thousands of suggestive questions that can be given in the geography lessons. The comparing of one continent, or river-basin, with another; one group of States with another group; of one state with the other states in its group, and also with other than those in its group, would fill a volume much larger than any text book on arithmetic yet published. Were such questions given in place of the dry, meaningless questions often given in the adding, substracting, multiplying, and dividing, of the, so-called, abstract numbers, children would not grow to be men and women and not know that California is larger than all the New England States with New York, Pennsylvania and New-Jersey thrown in, as is now often the case.

For other excellent problems in this line, see Jackman's Number in Nature Study.

BOARD MEASURE.

Any board, one inch or less thick, containing a surface area of 144 square inches, is called a board foot. All lumber is bought and sold by the board foot. The price is generally given for 1,000 board feet, i. e., if one says he is selling lumber at $40, we understand he sells it for $40 per thousand board feet.

1. How many board feet in a strip 1 inch wide and 12 feet long?
2. How many board feet in a strip 2 inches wide and 12 feet long?
3. If the strip is 12 feet long and 3 inches wide, how many board feet?
4. If 4 inches wide and 12 feet long?
5. If 5 inches wide and 12 feet long?
6. What is the law? When a board is 12 feet long it contains just as many board feet as it is inches wide.
7. If 7 inches wide and 12 feet long?
8. If 10 inches wide and 12 feet long?
9. How many board feet in six boards, each 5 inches wide and 12 feet long?

NOTE.—Each board being 12 feet long and 5 inches wide must contain 5 board feet, and six boards contain 6x5 board feet, or 30 board feet.

10. How many board feet in 100 boards, each 8 inches wide and 12 feet long?
11. What if the boards (Ex. 10) had been but 6 feet long? Since they would have been but one-half as long, they would have contained but half as many board feet—one-half of 800 board feet is 400 board feet.
12. How many board feet in 100 boards, each 8 inches wide and 9 feet long?

NOTE.—First think of them as being 12 feet long and then take such a part of the answer as the length of the board is of 12. In this example it is three-fourths; hence, three-fourths of 800, or 600, is the answer.

13. How many board feet in 50 boards, each board being 6 inches wide and 8 feet long?
14. How many board feet in 96 boards, each board being 7 feet long and 10 inches wide?
15. The following table is taken from the business card of one of Chicago's largest firms, and contains any number of problems. Notice that if the answer contains a fraction less than $\frac{1}{2}$, it is dropped, while if it is $\frac{1}{2}$ or more, another foot is added.

LUMBER MEASURE, JOIST, SCANTLING AND TIMBER.

SIZE.	12	14	16	18	20	22	24	26	28	30
2x 4	8	9	11	12	13	15	16	17	19	20
2x 6	12	14	16	18	20	22	24	26	28	30
2x 8	16	19	21	24	27	29	32	35	37	40
2x10	20	23	27	30	33	37	40	43	47	50
2x12	24	28	32	36	40	44	48	52	56	60
3x 6	18	21	24	27	30	33	36	39	42	45
3x 8	24	28	32	36	40	44	48	52	56	60
3x10	30	35	40	45	50	55	60	65	70	75
3x12	36	42	48	54	60	66	72	78	84	90
3x14	42	49	56	63	70	77	84	91	98	105
4x 4	16	19	21	24	27	29	32	35	37	40
4x 6	24	28	32	36	40	44	48	52	56	60
4x 8	32	37	43	48	53	59	64	69	75	80
6x 6	36	42	48	54	60	66	72	78	84	90
6x 8	48	56	64	72	80	88	96	104	112	120
6x10	60	70	80	90	100	110	120	130	140	150
8x 8	64	75	85	96	107	117	128	139	149	160
8x10	80	93	107	120	133	147	160	173	187	200
8x12	96	112	128	144	160	176	192	208	224	240
10x10	100	117	133	150	167	183	200	217	233	250
10x12	120	140	160	180	200	220	240	260	280	300
12x12	144	168	192	216	240	264	288	312	336	360
12x14	168	196	224	252	280	308	336	364	392	420
14x14	196	229	261	294	327	359	392	425	457	490

1. See first horizontal line. If a board were 12 feet long and 4 inches wide it would contain 4 board feet. The joist being 2 inches thick contains 2x4 board feet, or 8 board feet.

2. If 14 feet long, it is $\frac{1}{6}$ longer than 12, hence it contains $\frac{1}{6}$ of 8 board feet more. $\frac{1}{6}$ of 8 is $1\frac{1}{3}$, the fraction being less than one half, we drop it, and add 1 to 8, making 9 board feet.

3. If 16 feet long, it is $\frac{1}{3}$ longer than 12, hence it contains $\frac{1}{3}$ of 8 board feet more. $\frac{1}{3}$ of 8 is $2\frac{2}{3}$, the fraction being more than $\frac{1}{2}$, we add another foot, and add 3 to 8, making 11 board feet, etc., etc. Notice the lengths are always an even number, 12, 14, 16, etc.

The width of a board is also reckoned to the next smaller half-inch. A width of $8\frac{3}{4}$ inches is called 8 inches, while $9\frac{1}{4}$ is called $9\frac{1}{2}$ inches.

Shingles, as a rule, are laid 4 inches to the weather, and 1,000 shingles are estimated to cover 100 square feet. This allows for waste.

A bunch of lath 4 feet long and containing 100 pieces, is estimated to cover 5 square yards.

16. How many bunches of lath must I buy to lath a room 24 feet square and 9 feet high?

17. I have a gable roof 50 feet long and each of the two sides $22\frac{1}{2}$ feet wide. How many thousand shingles must I buy to cover it?

18. A hall is 3 by 15 feet and 10 feet high. How many bunches of lath must I get to cover its walls and ceiling?

19. My roof is 40 feet long and 18 feet wide. How many shingles will cover it?

SUGGESTIVE QUESTIONS ON CHART XXXIV.

1. How many board feet in the largest square piece of timber that can be cut from a log 12 feet long and twenty inches in diameter? See a cut of the log, Fig. 80, drawn on a scale of $\frac{1}{8}$ inch to an inch.

Fig. 81 shows the same log surrounded by a square whose sides are tangent to it. How many boards 1 inch thick could be cut from such a square timber? no allowance for sawing.

2. How many board feet would there be in each board? How many board feet in all?

3. Fig. 82 shows the same log again, this time is shown the largest square timber that can be cut from it. How does it compare with the timber, Fig. 81, that contained 400 board feet? Then how many board feet does it contain?

CHART XXXIV.

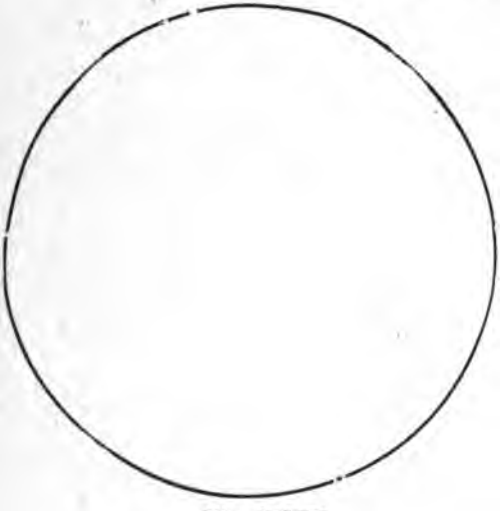


Fig. LXXIX.

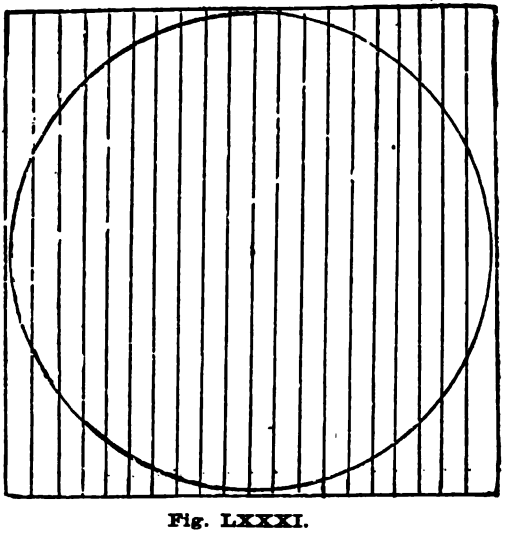


Fig. LXXXI.

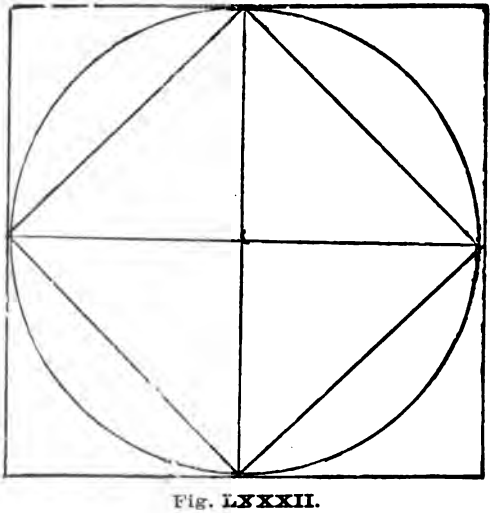


Fig. LXXXII.

4. Copy and fill the blanks.

To find the board feet in the largest square piece of timber that can be cut from a log of given diameter, we —— the diameter and take one —— of the ——, then take such a part of the answer as the length of the log is of 12.

5. How many board feet in the largest square timber that can be cut from a log 12 feet long and 12 inches in diameter?

NOTE.—$12^2=144$, $\frac{1}{2}$ of $144=72$, answer.

6. What if the log had been 10 inches in diameter?

7. What if it had been 30 inches in diameter? 14 inches? 15 inches?

8. What if the log had been 8 feet long and 30 inches in diameter?

9. What if the log had been 20 inches in diameter and 9 feet long?

GOOD TESTS FOR CAREFUL PUPILS.

NOTE.—In the work here given care must be taken that everything is done accurately, or bad mistakes will follow. Careless children will seldom, if ever, get correct answers to the problems. Here, as in sloyd work, every part must be made to fit or the whole plan will be wrong.

Just such lots are found where there are railroads.

1. Andrew Williams owned a lot which was described as follows: Beginning at the northwest corner, the boundary line point A ran east 40 rods to a point B. From B south 16 rods to a point C. From C west 24 rods to a point D. From D northwest to the place of beginning. How many rods from A to D? How many square rods in the lot?

2. My lot is bounded as follows: Beginning at the N. W. corner, which we may call A, the northern boundary runs east 48 rods to a point B. From B south 20 rods to a point C. From C the line runs northwest in direct line for A 12 rods to a point D. At D it turns, forming a right angle with D C and extends southwest 8 rods to a point E. At E it turns northwest, again forming a right angle, this time with D E, and extends 17 rods to a point F. From F it extends

northwest to A, the point of beginning. How long is A F? (Scale, $\frac{1}{8}$ inch to 1 rod.) What is the lot worth at $100 an acre?

3. Mr. White owned a rectangular piece of land whose north and south sides were each 32 rods long, and whose east and west sides were each 24 rods long. Two railroads cut off portions of it. One took all west of a line beginning at the northwest corner and running southeast to a point 16 rods west of the southeast corner. The other took all east of a line beginning at a point 12 rods south of the northeast corner and running southwest to a point 8 rods west of the southeast corner. Mr. White then sold one road a N. E. corner lot facing the east, having a front of 198 feet, and being 132 feet deep. How much land did Mr. White still own?

4. In a lot was a race track, every point of the longer boundary line of which was 11 rods from the center of the lot, and every point of the shorter boundary was 10 rods from the center. How much was used for the track? There are two ways to work this: One way being very much shorter than the other. Who is sharp enough to find the short way?

5. I have a lot that is called the "flatiron" lot, each side of which is 32 rods long. What is it worth at $40 per acre? Draw a map of the lot, using a scale of 1 inch to 8 rods. Another lot was bounded as follows: From A south to B the line was 40 feet long. From B west to C 30 feet. It then ran northeast to place of beginning. What would it cost to sod it at 4 cents a square foot? How many pickets, 4 inches wide and placed 2 inches apart, must I buy for a fence? If the pickets were 9 feet long, what would they cost at $20 per thousand board feet?

6. How many acres in Mr. A.'s garden, whose boundaries may be described as follows: Beginning at the northwest corner at a point A the fence extends directly eastward to a point B, a distance of 24 rods, then extending in a southeasterly direction 8 rods east of point C, which is 16 rods directly south of B, to point D. Then turning in a southwesterly direction at right angles with B D for a distance of 12 rods to point E, then due west for 16 rods to a point F, then northwest to the place of beginning?

7. Draw a plan of your garden on a scale of $\frac{1}{8}$ inch to one rod, by placing a point A near the upper right hand corner of your paper, from here draw a line 24 rods west to point B. From point B draw a line south 32 rods to point C. Place a point E 16 rods south of point A. Place a point D 8 rods west of point E; connect C and D. How far is it from C to D? What will it cost to plow the garden at $1.25 per acre?

8. A man has a lot which, beginning at a point A at the northwest corner, the boundary line extends east 16 rods; thence directly south 16 rods; thence directly west 16 rods. From A it runs southwest to a point 24 rods directly west of a point in the center of the eastern boundary; thence southwest to the western end of the southern side. How many bushels of potatoes will he raise, allowing 14 bushels to the acre?

9. What will it cost to fence the north side of my lot, six boards high, with boards 16 feet long and 4 inches wide, at $20 per 1000 board feet? The boundary line of the lot began at point A (the northeast corner) and extended south 16 rods to a tree (point B). From the point B directly west 24 rods to a stump (point C). From C northeast in direct line with point A, 12 rods to point D. From D directly west 12 rods to point E. From E directly north 9 rods to point F. From F to A, the place of beginning. What was this lot worth at $90 per acre?

10. What is my land worth at $45 per acre that may be shown by the following plan, on a scale of $\frac{1}{8}$ inch to one rod? Beginning near the northwest corner of your paper at a point A, draw a line 24 rods to a point B. Making a right angle at B, place a dot 16 rods south from B. From this dot directly east 8 rods, make a dot marked C. Connect B and C. From C directly west draw a line 16 rods to a point D. Connect D A.

11. (Scale $\frac{1}{8}$ inch to one rod). From a point A, draw a line 24 rods west to a point B. From A draw a line south 8 rods to C. From B draw a line southwest 25 rods to a point D, where a line drawn west from C would meet it. From D draw a line 34 rods southeast to a point E, 32 rods south of B. Connect E and C. Find the number of acres in this field.

12. The boundary line of a town is as follows: Beginning at the northwest corner A, extending east 27 miles to B. Turning at B and running 9 miles in a southwesterly direction to C. From C, extending directly west 27 miles to D. From D to point of beginning. What is the length of the town's boundary lines? How many acres does it contain? (Scale, 2 inches to 9 miles).

13. A man owned a lot 120 rods square. A railroad ran through it as follows: One fence line began at the northeast corner and ran straight southwest to the southwest corner. The other fence line began at a point 80 rods north of the southeast corner and also ran straight southwest to a point 40 rods east of the southwest corner. What should the railroad company pay for the land lying between the fences at $90 per acre? How many posts will be required to fence the two sides, allowing two posts to a rod?

14. At an average of 30 bushels to an acre, how much will I receive for the wheat, at 60 cents a bushel, raised on a field bounded as follows: (Scale $\frac{1}{8}$ inch to 4 rods.) Beginning at A, the southeast corner, the fence line ran north 80 rods to point B. Turning at B it ran west 96 rods to point C. Turning at C it ran south 20 rods to point D. From D it ran southeast to A, the place of beginning?

15. Represent a field by drawing (scale $\frac{1}{8}$ inch to 1 rod), from A, a line east 14 rods to B. From B continue A B in a dotted line east 10 rods to C. 12 rods north of C place a dot at D. Connect B and D by a straight line. From D draw a line south 26 rods to E. From E west 20 rods to F. From F 8 rods toward A to G. From G southwest at right angles 10 rods to H. Connect H and A by a straight line. How many acres in enclosed lot?

16. (Scale 1 inch to 1 rod.) I have a field whose boundary extends from a point A 4 rods east to a point B; from B due northwest to a point C, 2 rods north of the middle point of A B. From C 4 rods west to D; and from the point D 3 rods south to a point E; from E to the point of starting. What will it cost to sod this plot of ground at 36 cents a square yard?

17. The boundary of a lot may be represented as follows: From A draw a line 16 rods east to B (scale $\frac{1}{4}$ inch to 1 rod). From B

draw a line 12 rods south to C; from C draw a line northwest to A; from A draw a line 14 rods south to D; from D draw a line northeast to B. What is the value of the lot at $75 per acre?

18. (Scale $\frac{1}{8}$ inch to 1 rod.) From a point A draw a line east to B 32 rods; then south at right angles with A B, a line to C, 14 rods; west at right angles with B C, 16 rods to D; northwest in the direction of point A, 11 rods to E; from A south, at right angles with A B, to F, 14 rods; from E to G in a line parellel to A F, 16 rods, from F to G. What will it cost to plow it at $3 per acre?

19. A man bought a lot whose dimensions were as follows: (Scale $\frac{1}{4}$ inch to a rod.) Beginning at the northeast corner, point A, it ran south 12 rods to point B; from B directly west 24 rods to point C; from C north 8 rods to point D; from D west 10 rods to point E; from E north 12 rods to point F; from F southeast to point A. How much would this land cost at $125 an acre.

20. (Scale $\frac{1}{8}$ of an inch to 1 rod.) Beginning at point A draw a line toward the east to point B, 32 rods long; from point B draw a line south 20 rods to point C; from C draw a line toward the east 16 rods to D; from D toward the south 24 rods to E; from E toward the west 24 rods to F; from F to place of beginning. What is the value of the land at $85 an acre?

21. (Scale $\frac{1}{4}$ inch to 10 feet.) Let point A be the northwest corner of a field. Draw a line from point A south to B, 40 feet; from B east to C, 80 feet; from C south to D, 60 feet; from D northwest towards A, to point E, 60 feet; from E south to F, 120 feet; from F east to G, 120 feet; from point A draw a line east to M, 240 feet; from M southwest towards G to point O, 80 feet; from O east to F, 40 feet; from F to G. Find the area of a field with these given dimensions. Answer in acres.

22. A business block takes the following form: At a point A it extends directly east 6 rods to a point B (scale 1 inch to 1 rod); from B to a point northwest to a point C, which is 4 rods directly north of the middle of A B; from C it extends southwest to the starting point. This business block is near the railroad and has a fence along

the western boundary. How many feet long is the fence? What is the block worth at $4,000 an acre?

23. A man had a farm with the following dimensions: From a point A directly south to a point E, 16 chains; from E directly east to a point D, 12 chains; from D directly north to a point C, 6 chains. There was a hedge from C to A, $15\frac{1}{2}$ chains. From E to C there was a hedge which formed the northwest boundary line of a field (E, C, D) of wheat. From C directly west to the western boundary of the farm to a point B, there was a hedge which formed the northern boundary of a field (B, E, C) of oats, and north of this field was a pasture. How many acres in the field of wheat, the field of oats and the pasture?

24. Mr. H. starts from A and goes north 14 rods to B, then east 14 rods to C, then in a semi-circle in a southwesterly direction to a place called D, 14 rods west of B, then from D in a semi-circle in a southeasterly direction to B, then from B northeast to a point F, which is 12 rods north of the middle point of B C, then from F east to G 14 rods, then from G to B. If Mr. H.'s journey were to be a line fence, how many acres of land would the fence inclose?

25. (Scale $\frac{1}{8}$ inch, 1 rod.) Beginning at point A, draw a line 32 rods long toward the east to point B. From point B draw a line toward the southwest meeting at point C, a line 16 rods long parallel to A B, whose middle point is 24 rods from the middle point of A B. Draw the line completing the figure. Problems: How many acres in the field? How many 8-foot (4-inch) boards will it take to build a fence five boards high? What will it cost at $20 per thousand board feet?

26. (Scale, 1 inch to 8 rods.) Mr S owns an odd piece of land fenced in for a ball ground, whose boundaries may be described as follows: Beginning at the northwest corner the boundary extended directly eastward for a distance of 18 rods, then turning toward the southeast it runs to a point F, 8 rods east of K, a point 16 rods directly south of point B; then turning again in a southwesterly direction to point C, which is 16 rods directly south of point K; from point C it extended directly westward for a distance of 18 rods

to point D; then turning southwestward to a point H, which is 8 rods west of a point M, 16 rods north of point D, and from thence toward the northeast to place of starting. What is the lot worth at $80 an acre?

27. In a rectangular lot whose northern and southern boundary lines were each 56 feet long and whose eastern and western boundary lines were each 64 feet long, some boys had a race track. Every point on the longer boundary line of the track was 24 feet from the center of the field, and the shorter one was 18 feet from the center. How many times must a boy walk around the center of the track to walk one mile? They had all that part of the lot outside of the track covered with sodding. What would it cost at 4 cents a square foot? (Draw a diagram $\frac{1}{8}$ inch to 2 feet for a scale.)

28. A man began at B and walked east 40 miles to C, then north 30 miles to D, then from D southwest to B again. How many miles did he walk? (Draw diagram scale, 1 inch to 10 miles.)

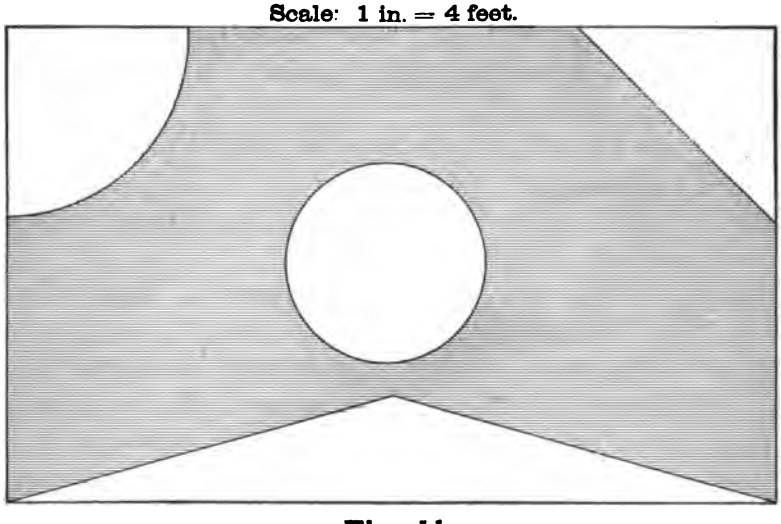


Fig. H.

29. See Fig. H. (The cut is faulty. Both sides of the quadrant should be 1 inch and the altitude of the south triangle ½ inch, its base 4 inches.) In the northeast corner are pansies; in the north-

west corner forget-me-nots; in the inner circle geraniums; the south side triangle is water; the rest green grass. What did it cost to sod it at 4 cents per square foot?

RIGHT TRIANGLE.

1. Cut out a right triangle having a base 3 inches long and a perpendicular 4 inches long. How long is the hypothenuse?

2. Cut out a square each of whose sides will be the same length as the base of the right triangle.

3. Cut out a square each of whose sides will be the same length as the perpendicular of the triangle.

4. Cut out a square each of whose sides will be the same length as the hypothenuse of the triangle.

5. Place the 3-inch square so that one of its sides will meet the base of the triangle. Next place the 4-inch square so that one of its sides will meet the perpendicular, and then place the 5-inch square so that one of its sides will meet the hypothenuse.

6. What is the area of the base's square? Of the perpendicular's? Of the hypothenuse's?

7. How does the area of the hypothenuse's square compare with the other two squares?

8. See if this is true of a right triangle with a base 6 inches and a perpendicular 8 inches.

9. See if it is true of a right triangle with a base 9 inches and a perpendicular 12 inches.

10. What if the base were 24 inches and the perpendicular 18 inches? Fill in the blanks. The square of the hypothenuse of a right triangle is equal to the — — — — of the — — sides.

NOTE.—See any good text book for an explanation of extracting the square root of a number. We would suggest, however, that if the teacher will take a paper 24 inches square and divide it into square inches and from this paper cut out the square of the tens, the children will readily see that what is left is two oblongs and one square, with the area of the oblongs equal to two times the tens by

the units, and the area of the square equal to the square of the units. Having thus taken it apart they can build it up again and tell her that the square of a number composed of tens and units is *equal* to the $U^2 + 2\ T\ U + T^2$. Hold up each piece and let them tell what it is and they will give you the formula, not as written above but in their own language. and after having done so the formula is soon mastered.

WRITTEN WORK.

11. Two boys start to walk from a place B at the same time, John walks north 9 miles and Will walks west 12 miles. How far are they apart?

12. There is a wall 16 feet high. The foot of a ladder is 12 feet from the wall. How long must the ladder be to reach the top of the wall?

13. The area of a square built on the hypothenuse of a right triangle was 3,364 square inches. How long was the hypothenuse?

14. A ladder 20 feet long, when placed 16 feet from a wall, just reached its top. How high was the wall?

15. A string 45 yards long was thrown from the top of a tree 27 yards high, on the right bank of a creek, to the opposite bank. How wide was the creek?

16. A rectangular field is 192 yards long and 144 yards wide. How far is it from the N. E. corner to the S. W. corner of the lot, the shortest distance?

17. "Four boys, A, B, C and D, live in different places as follows: A, 40 rods north of the school house; B, 60 rods east; C, 57 rods south, and D, 36 rods west. What is the shortest distance one of the boys must travel to visit all the rest, and reach his own home?"

18. A letter carrier lived 18 rods east from the postoffice. Monday morning he walked to the office, then north 24 rods to A's. From A's he walked home the shortest distance, then back to the office. From the office he went 96 rods south to B's. From B's northwest to C's, who lived 72 rods west of the office. From C's he went direct to the office and from there direct to his home again for

dinner. After dinner he returned to the office, then went to B's and C's again, taking the same road as before. From C's to the office and from the office home. How many miles did he walk?

SUGGESTIVE QUESTIONS ON CHART XXXV.

1. See Fig. 83. What do we call such a solid? What are the sides of this pyramid? How many sides has it?

2. Each side may be thought of as a rectangle how wide and long?

3. How many such rectangles will there be? If placed side by side what kind of a rectangle would they make? See Fig. 87.

4. Fill in the blanks. When finding the area of the sides of a pyramid we may think of a rectangle with a base equal to the perimeter of its base and an altitude equal to —— its slant ——.

5. What is the area of the sides of a square pyramid with a slant height of 15 inches and the side of the base 3 inches?

LESSON II.

1. See Fig. 84. What is its name? If its base were 12 inches in circumference, how many triangles with a 3-inch base could be drawn on its surface? If the slant height were 6 inches, each triangle would equal what rectangle? A rectangle —— by ——.

2. How many such rectangles would there be? If placed side by side they would make one rectangle how wide and long? A rectangle —— by ——.

3. Fill in the blanks. When finding the area of a cone, we may think of a rectangle with a base equal to the —— of the cone's —— and an altitude equal to —— the slant height of the cone?

4. How much will it cost to paint the circular spire of a church whose slant height is 50 feet, and the diameter of whose base is 14 feet, at 25c. per square foot?

CHART XXXV.

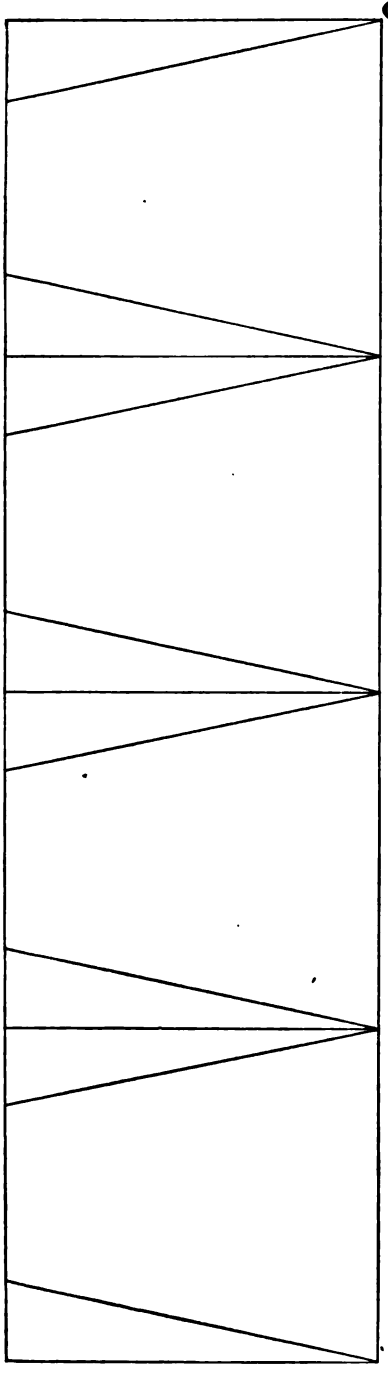


Fig. LXXXVII.

Fig. LXXXIII.

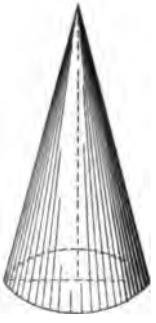


Fig. LXXXIV.

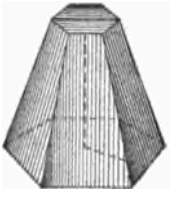


Fig. LXXXV.

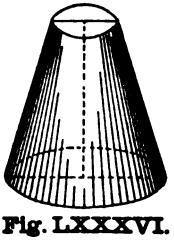


Fig. LXXXVI.

LESSON III.

1. See Fig. 85. What do we call it? What are its sides?

2. If the perimeter of one end of this frustum were 36 inches, the perimeter of the other end were 12 inches, and the slant height were 4 inches, each side would make a rectangle how long and wide? A rectangle —— by ——.

3. How many such rectangles would there be? If placed side by side, making one rectangle, how long and wide would it be? 2 inches by —— inches.

4. Fill in the blanks. When finding the area of the sides of a frustum of a regular pyramid or cone we may think of a rectangle with a base equal to the —— of its two —— and an altitude equal to —— its slant height.

NOTE.—The surface of a sphere is not developable. Multiply the circumference by the diameter.

WRITTEN WORK.

1. How many square inches of leather will it take to cover a ball 7 inches in diameter?

2. The circumference of a ball was 44 inches. How many square inches will it take to cover it?

3. What is the entire surface of a pyramid whose base is 12 inches square, and whose slant height is 30 inches?

4. What is the entire surface of a cone, the diameter of whose base is 21 feet, and whose slant height is 42 feet.

5. What will it cost to gild a sphere 12 feet in diameter at 25 cents per square foot?

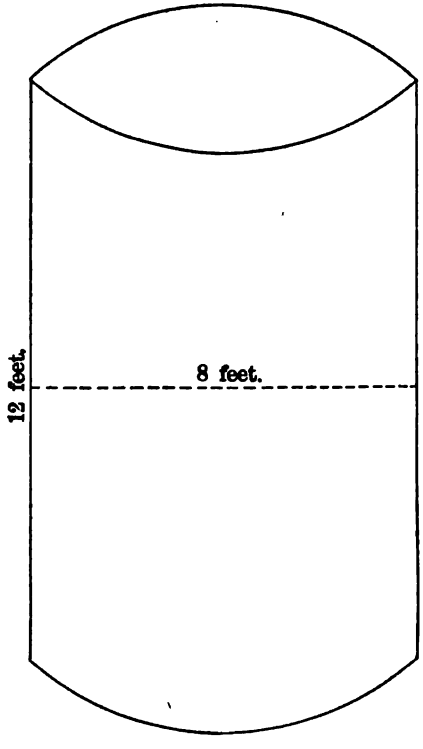
6. What is the entire surface of a cylinder 42 inches in diameter and 6 feet long?

7. What is the entire surface of a square prism with a base of 4 feet and a height of 30 feet?

8. What will it cost to plaster a cylindrical cistern 8 feet in diameter and 6 feet deep at 4 cents a square foot?

9. A cylindrical cistern is 7 feet deep and 28 feet in circumference. At 36 cents a square yard, what will it cost to plaster it?

10. My cistern is 7 feet in diameter and 5 feet deep. How much must I pay to have it plastered at 36 cents a square yard?



11. At 50 cents a square foot, what will it cost to plaster this cylindrical cistern?

GOVERNMENT LANDS.

When measuring Government lands, a line is first run north and south. This line is called the *Principal Meridian.*

Parallel to the principal meridian, and 6 miles apart, other lines are run dividing the country into strips called Ranges. The ranges are numbered in order, both east and west from the P. M.

If one wished to show that he was writing of the fourth range east of the principal meridian, he would do so thus: R. 4, E.

What is the meaning of R. 3, E.? Of R. 4, W.?

A line is next run east and west, called the *Base Line.*

Other lines are run parallel to the base line, also 6 miles apart, thus dividing the ranges into squares of 36 square miles each. These squares are called *Townships*, which are numbered in order, both north and south, from the B. L.

This makes it possible to locate any part of the survey, e. g. T. 17, N. R. 5, W. is the seventeenth township north of the base line, in the fifth range west of the principal meridian.

Locate the following: T. 16, S. R. 4, W. Also this: T. 3, S. R. 7, E.

A township is divided into 36 equal parts called *Sections*, each being one mile square. The sections are subdivided into half-sections, quarter-sections, half-quarter-sections and quarter-half-sections.

The sections of a township are numbered from the north-east corner across to the west, and back on the second line of sections to the east, and thus back and forth, as is shown in Fig A.

N.

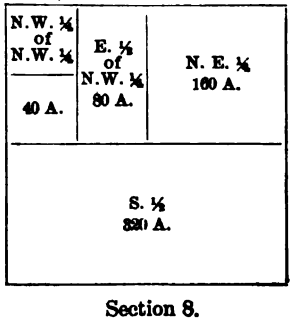
	6	5	4	3	2	1
	7	8	9	10	11	12
W.	18	17	16	15	14	13
	19	20	21	22	23	24
	30	29	28	27	26	25
	31	32	33	34	35	36

E.

S.

Township.

Fig. A.



Section 8.

Fig. B.

Each section is divided into halves and quarters, and the quarters are subdivided into halves and quarters, and designated, as is shown in Fig. B. Thus, the N. W. ¼ of N. W. ¼, Sec. 8, designates the northwest quarter of the north-west quarter of section 8.

A section contains 640 acres; a half-section, 320 acres, a quarter-section, 160 acres, etc.

1. See Fig. C. Describe Mr. Smith's farm. How many acres has he? Also Mr. Cook's.

2. Describe Mr. Brown's farm and tell how many acres he has. Also Mr. Jones'.

3. Describe Mr. Johnson's farm. What is its value at $80 per acre.

4. Describe Mr. Williams' farm. His wheat averaged 40 bushels to the acre. How many bushels had he?

5. Draw a map showing Mr. White's farm, it being the S. E. ¼ of the S. E. ¼ of the N. E. ¼ of the N. E. ¼. How many acres had he?

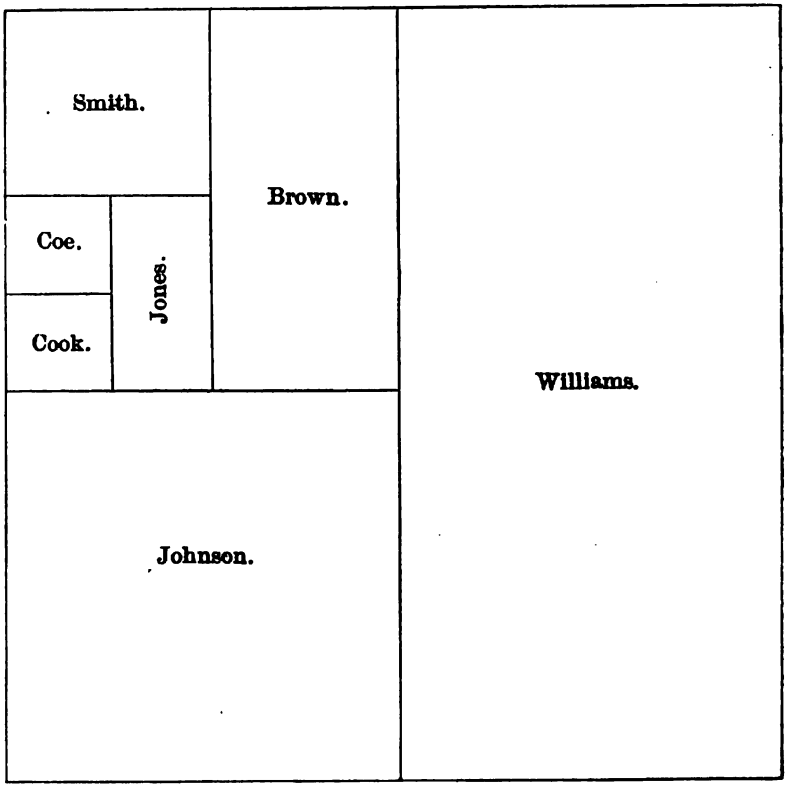


Fig. C.

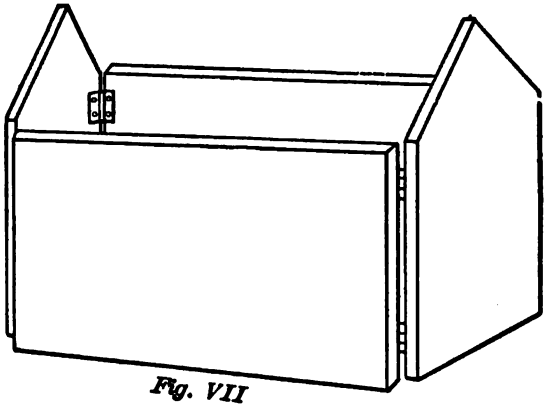


Fig. VII

NOTE.—To show the four walls of a room as a rectangle

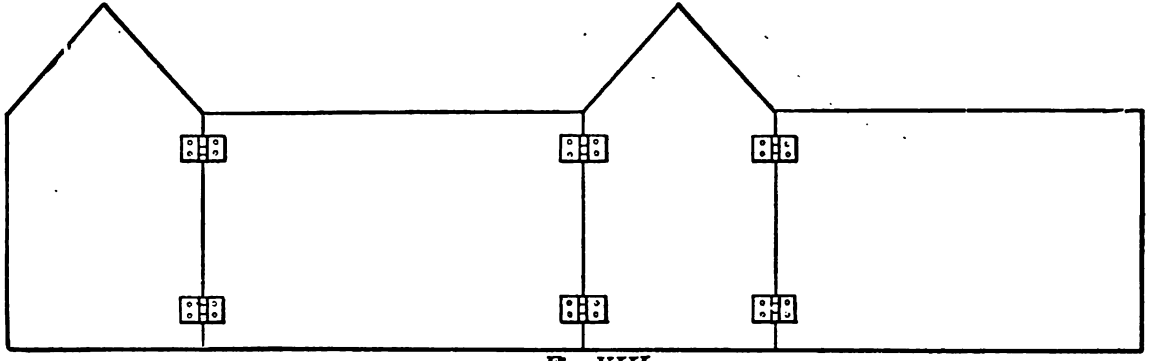
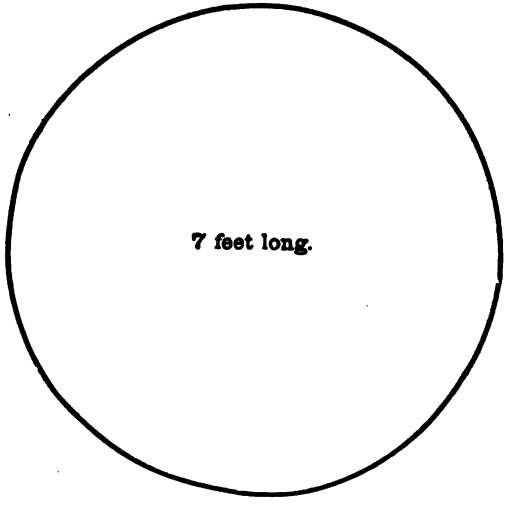


Fig. VIII



How many board feet in the largest square timber that can be cut from this log? $\frac{1}{16}$ in. to 1 foot.

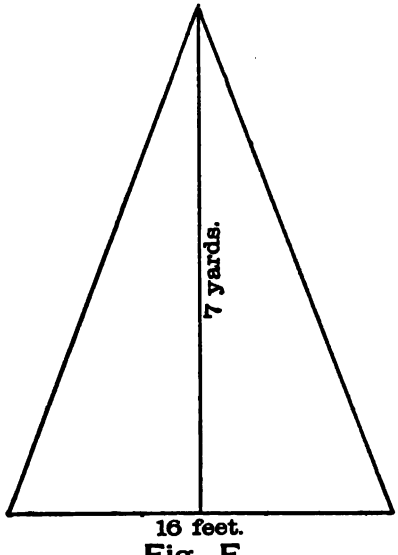


Fig. F.

Find the area of F.

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NOTE.—Charts 1 to 16, Part I, may also be used as tests in finding area. Good exercises, for seventh and eighth grades, are to find the hypothenuse of the right triangles found on the different charts.

SUPPLEMENTARY WORK

IN

ARITHMETIC.

VOLUME AND BULK.

BY

WM. M. GIFFIN,

AUTHOR OF GRADED REVIEWS, THE POPULAR READING CHART, ETC., ETC.

A. FLANAGAN,

CHICAGO.

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WM. M. GIFFIN

TO THE TEACHER.

Lead the children to see that when finding the volume of a solid they are finding the number of cubic units it contains, which are found in layers, of a given number of rows, of a given number of units in a row.

Add many questions to those given by the author, and encourage the children to ask original questions.

The charts in Part I on Lines and Part II on Area, are full of problems in fractions, lines, area, volume and bulk, if the children are only led to discover them.

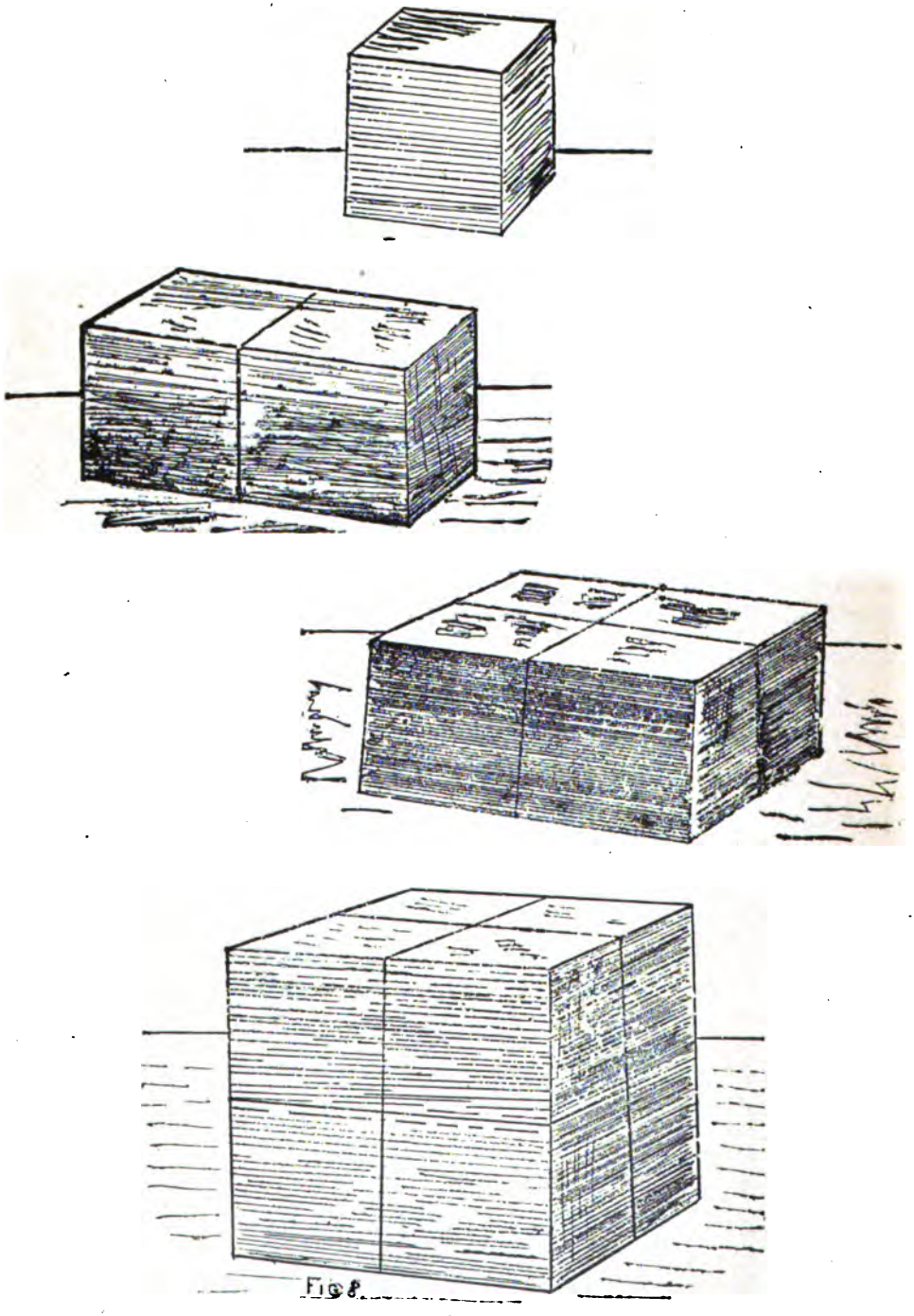


Fig 8.

VOLUME.

LESSON I.

NOTE.—Obtain a number of inch cubes. They can be had of any kindergarten supply store, or may be made by any good carpenter. Also a 2 inch, 3 inch, 4 inch and 12 inch cube. If "home made" the cost will be but a trifle. If thought best the lessons on volume may begin by having the children make a cubic inch box. See cut on the last page.

1. You may each hold up 1 of your inch cubes.
2. You may hold up an inch cube in each hand.
3. Place the 2 cubes in a row on your desk.
4. Place another row behind the first row.
5. How many rows of inch cubes have you?
6. How many inch cubes are in each row?
7. How many inch cubes in the two rows?
8. Place 4 more cubes on top of this four.
9. How many layers of cubes have you?
10. How many cubes in a layer?

LESSON II.

1. Show me a 2 inch cube.
2. Build a 2 inch cube with your inch cubes.
3. How many layers of inch cubes have you used?
4. How many rows are there in each layer?
5. How many inch cubes in a row?
6. How many inch cubes in each layer?
7. How many inch cubes in the 2 layers?
8. A 2 inch cube equals how many inch cubes?

9. How long is a 2 inch cube? How wide? How thick?

10. How many faces has a cube? How many edges? How many corners?

LESSON III.

1. Take off 1 of the inch cubes from your 2 inch cube. What part of the 2 inch cube did you take?

2. What part of a layer did you take?

3. What part of a row did you take?

4. Put back the cube. Now take off 2 cubes.

5. What part of the 2 inch cube did you take?

6. Tell another name for your answer.

7. The 2 cubes are what part of a layer?

8. What part of a row are they? How many rows are there in all?

9. Three cubes are what part of the 2 inch cube? Four are what part?

10. Five of the cubic inches are what part of the 2 inch cube? Six are what part? Seven are what part? Eight?

LESSON IV.

1. One layer is what part of the 2 inch cube?

2. One row is what part of 1 layer?

3. If 1 layer is $\frac{1}{2}$ and 1 row is $\frac{1}{2}$ of 1 layer, then 1 row is $\frac{1}{2}$ of what part?

4. One row is what part of the whole 2 inch cube?

5. Then $\frac{1}{2}$ of $\frac{1}{2}$ is how much?

6. Again: One layer is what part of the 2 inch cube?

7. One inch cube is what part of 1 layer?

8. One inch cube is what part of what part?

9. One-fourth of $\frac{1}{2}$ is what part of the 2 inch cube?

10. One-fourth of $\frac{1}{2}$ equals what?

CHART XIX.

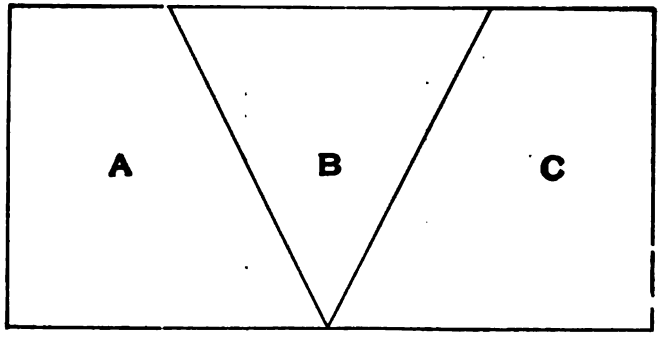


Fig. XXXVII

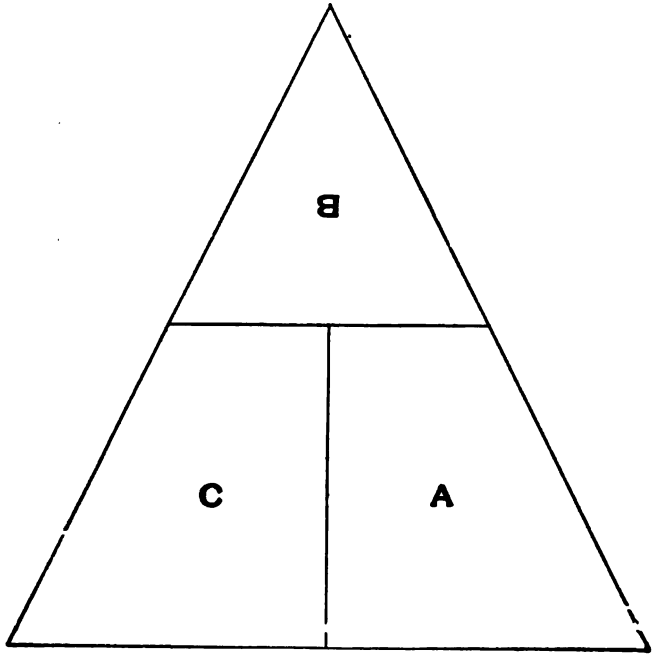


Fig. XXXVIII.

CHART XVII.

(See Part One, on Lines, for Charts from 1 to XVI.)

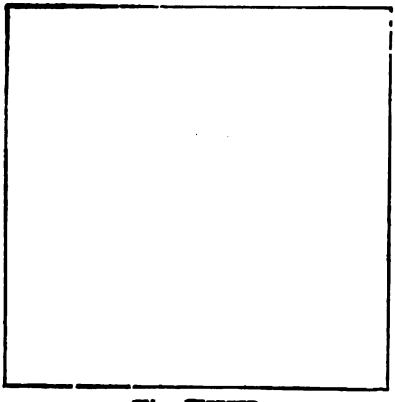


Fig. XXXI.

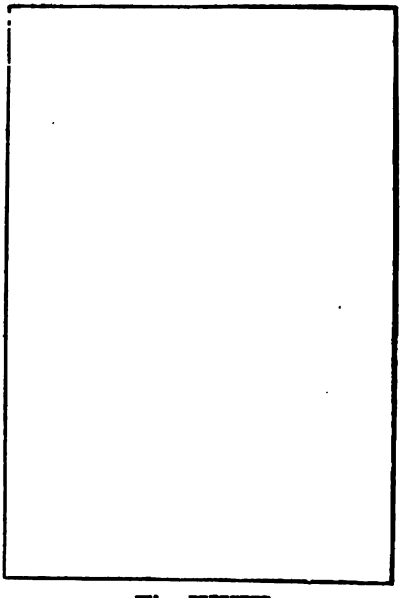


Fig. XXXII.

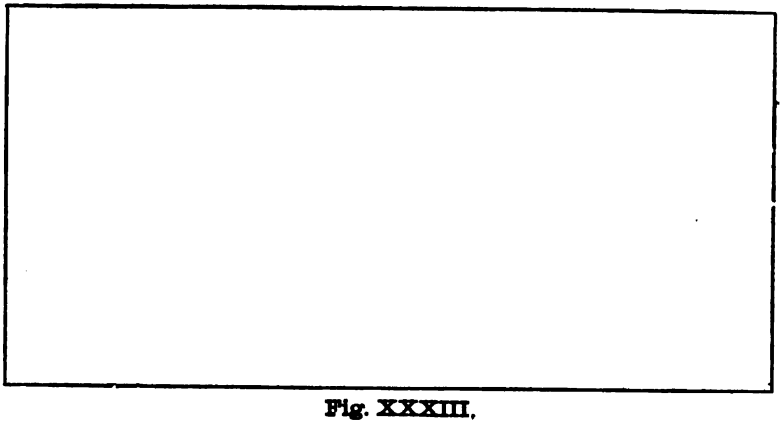


Fig. XXXIII.

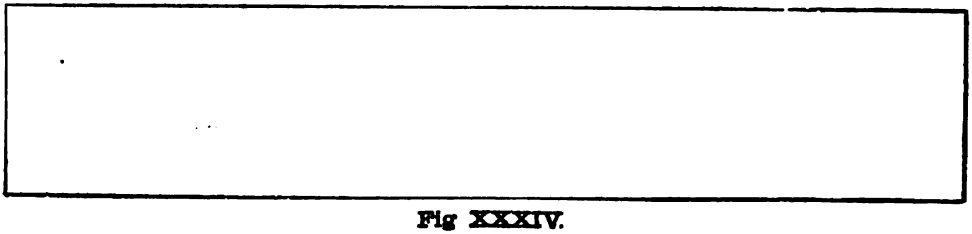


Fig XXXIV.

LESSON V.

1. Show me ½ of ½ of the 2 inch cube.
2. What part of the 2 inch cube is it?
3. Show me ¼ of ½. What part is that?
4. Show me ½ of ¼ of the 2 inch cube.
5. Show me ½ of ¾ of it. How many cubes is that? What part of the 2 inch cube?
6. One-third of ¾ equals what? One-half of ½ equals what?
7. One-half of ¼ equals what? One-fourth of ½ equals what?
8. Show me $\frac{1}{6}$ of ¾ of the 2 inch cube.
9. One-sixth of ¾ equals what?
10. How many eighths in a whole one? How many fourths? How many halves?

LESSON VI.

1. See Chart 17, Fig. 31, which shows one of the equal sides of a box. How many cubic inches will it hold?
2. How many layers will the box contain? How many rows in a layer? How many cubes in a row?
3. Fig. 31 shows one of the ends of a box, and Fig. 32 shows one of the sides of the same box. How many cubic inches will it hold?
4. How many of the cubes will touch the sides but not the ends of the box?
5. What part of the whole number touch the sides but not the ends?
6. How many of the cubes touch the ends?
7. What part of the whole number in the box touch the ends?
8. Those that touch the sides equal what part of those that touch the ends?
9. Fig. 33 shows the length of the sides and Fig. 31 shows the length of the ends of a box that is only one inch deep. How many cubic inches will such a box hold?

10. What part of the cubes in this box (Ex. 9) touch the sides only? How many eighths is that?

11. How many cubic inches can we put in a box whose bottom is like Fig. 34, if it is 1 inch deep? If it is 2 inches deep?

12. I have a box with its bottom 4 inches square and it is 2 inches deep. How many layers of cubic inches will it hold? How many rows of cubic inches in each layer? How many cubic inches in each row? How many cubic inches in the box?

13. How many of the cubic inches (Ex. 12) do not touch the sides or ends?

14. How many touch the sides of the box only?

15. How many touch only the ends of the box?

16. How many do not touch the sides, ends, or bottom of the box?

LESSON VII.

1. See Chart 22, Fig. 48. It is a plan of the ground floor of May's doll house. How many cubic inches could you put on this floor one layer deep?

2. How many of them would not touch the sides of the room?

3. How many would touch the sides of the room?

4. How many inch cubes could you put in the room if they were 2 layers deep?

5. How many 2 inch cubes could you put in the room, 1 layer deep?

6. To how many inch cubes would these 2 inch cubes be equal?

7. After putting in all the 2 inch cubes how many inch cubes could you add?

8. How many of the 2 inch cubes would touch 3 sides of the room?

9. How many of the 2 inch cubes would touch 2 sides of the room?

10. How many of the 2 inch cubes would touch only 1 side of the room?

CHART XXII.

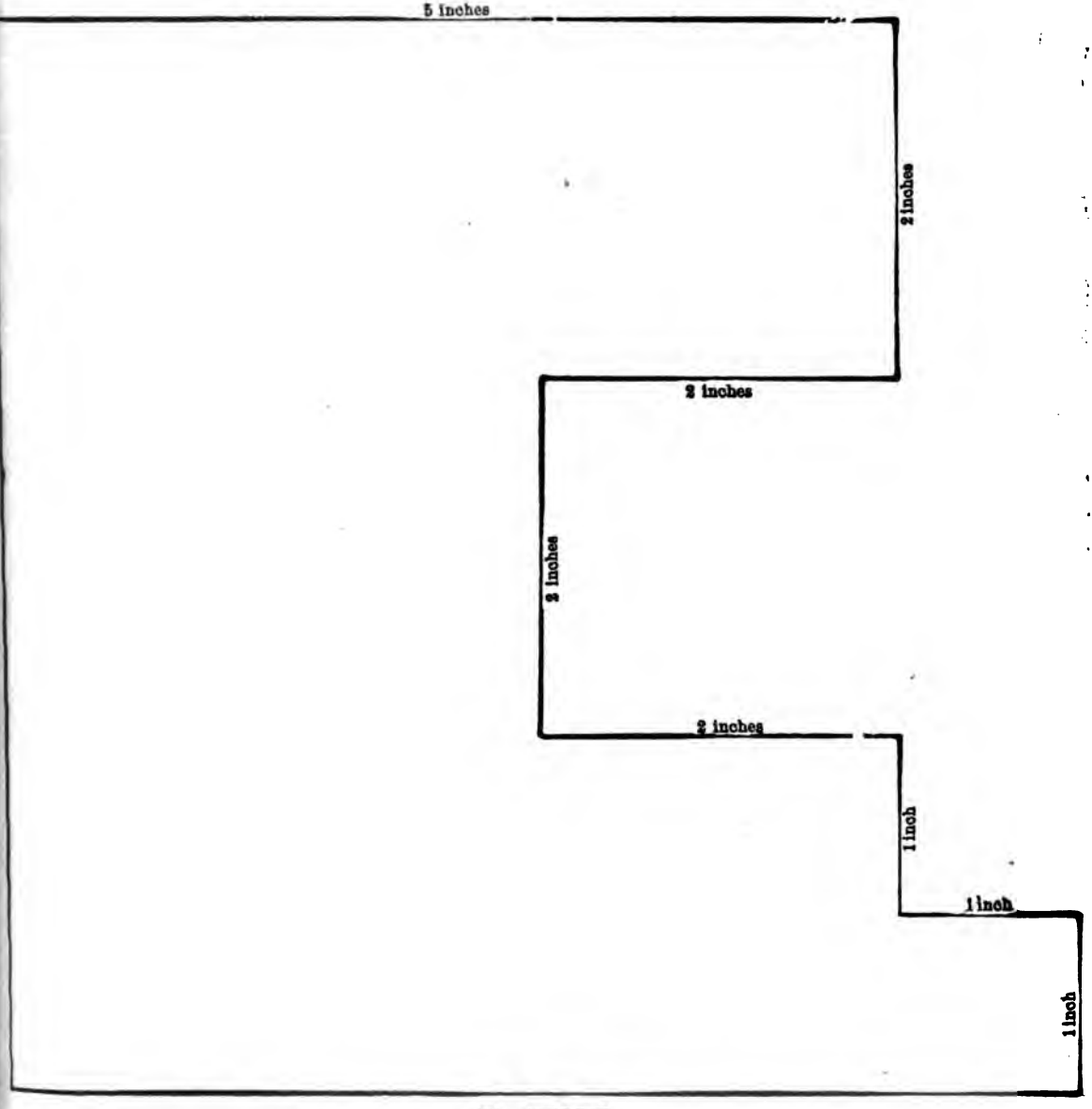


Fig. XLVIII.

11. I have a box that will hold just 1 cubic inch? How many ½ inch cubes will it hold?

12. John has a box that will hold just one 2 inch cube. How many ½ inch cubes will it hold?

13. One cubic inch equals what part of the ½ inch cubes in John's box?

14. One layer of inch cubes equals what part of the ½ inch cubes in John's box?

15. One-half of 1 cubic inch equals how many ½ inch cubes?

16. Henry has a box 4 inches long, 2 inches wide and 2 inches deep filled with inch cubes. What part of them do not touch any of the 4 sides of the box?

17. William has a box 3 by 3 by 3 inches, filled with inch cubes. How many does it hold?

18. By how many is the center cube touched?

19. One layer equals what part of the cubes?

20. One row equals what part of 1 layer?

21. One-third of ½ equals what?

LESSON VIII.

NOTE.—Before beginning this lesson show the class a cubic foot. This can be done by taking six pieces of card board, each one foot square. Sew or paste the edges together. Fill the box with any light substance, as saw dust, to keep it in shape, and then sew or paste on the top.

1. A box 4 inches long, 4 inches wide and 4 inches deep will hold how many cubic inches?

2. How many layers will it contain?

3. How many rows will there be in each layer?

4. How many cubic inches will there be in each row?

5. A box that is 4 feet long, 4 feet wide and 4 feet deep is full of sand. How many layers of cubic feet are there? How many rows

CHART XXVI.

Continued

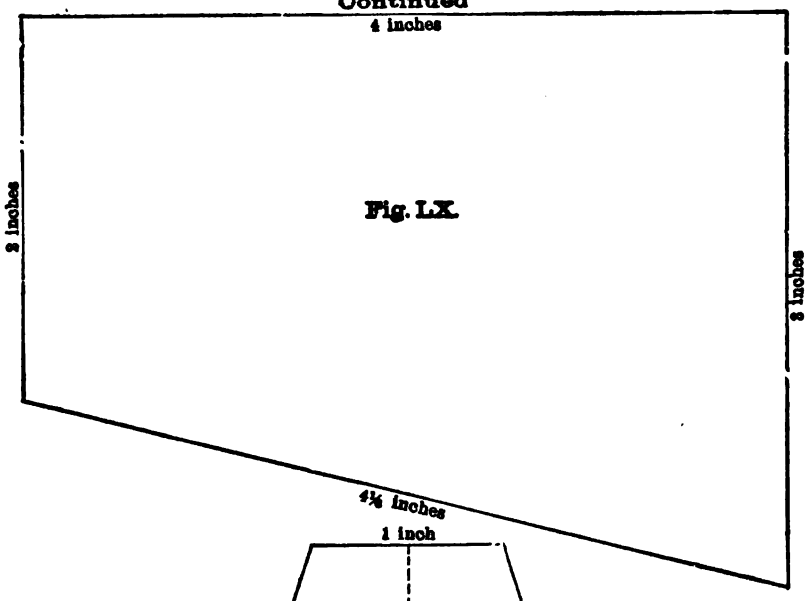


Fig. LX.

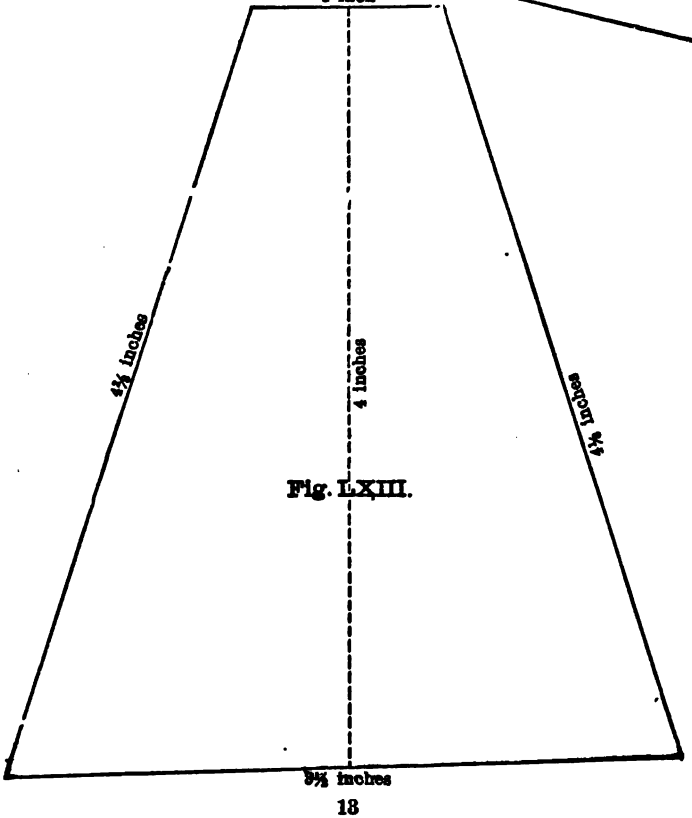


Fig. LXIII.

CHART XXIV.

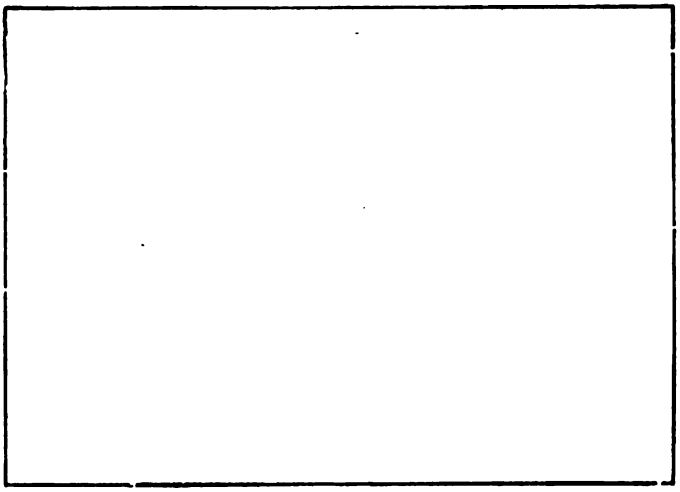


Fig. L.

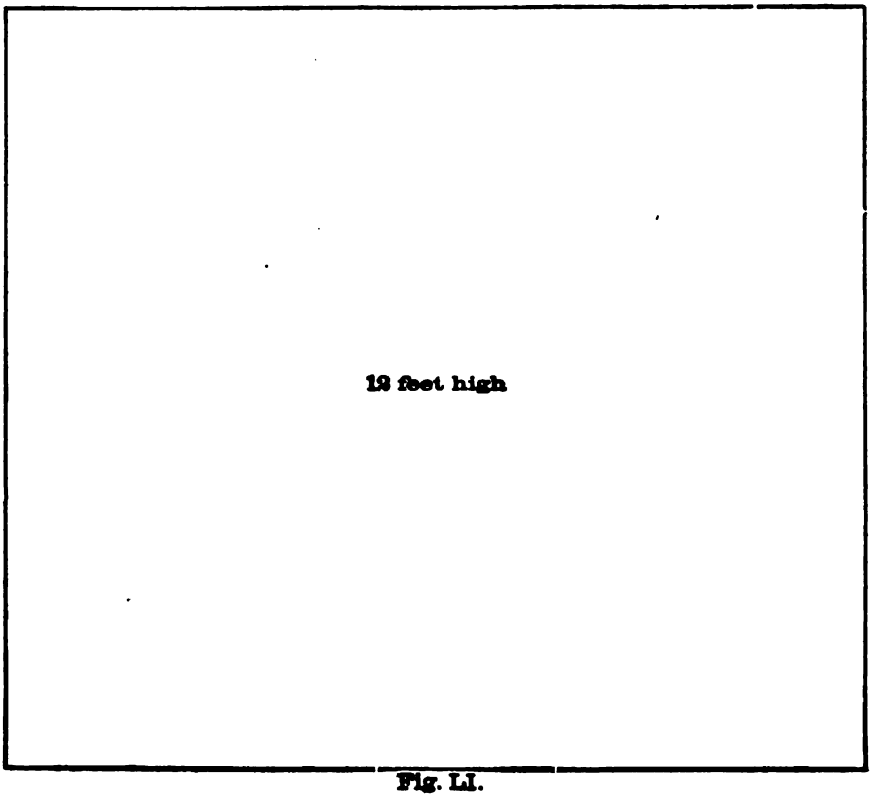


Fig. LI.

of cubic feet? How many cubic feet in each row? How many cubic feet of sand?

6. How many cubic feet of sand will a box hold that is 4 by 2 by 3 feet?

7. How many will a box 3 by 2 by 3 feet hold?

8. What if the box is 6 by 2 by 3 feet?

9. What if the box is 2 by 2 by 3 feet?

10. What if the box is 5 by 2 by 3 feet?

11. What if the box is 4½ by 2 by 3 feet?

12. What if the box is 3½ by 2 by 3 feet?

13. What if the box is 2½ by 2 by 3 feet?

14. What if the box is 3 by 1 by 3 feet?

15. What if the box had been 4 feet deep each time? 5 feet? 6 feet? 7 feet? 8 feet? 9 feet?

LESSON IX.

NOTE.—Before taking up this work talk to the class about building a house. What do we call the different mechanics who must be employed in building a house? Which part is made first? When is the best time to lay a foundation? Why? What is the best kind of stone? What kind of stone would not be well to use? Show me a sample of good foundation stone from my collection on the table. Show a sample of poor stone for foundation. What holds the wall together? Of what is the mortar made? Where do they get the lime? Where the sand? What must they do to the lime? Why? Show me a sample of good sand? Why better than this? What are the different materials of which houses are made? Is this the case with all peoples? What does the Eskimo use? The Indian? The pioneers of a woodless country use what? Who ever saw a sod house?

1. See Fig. 50, Chart 24. What will it cost to dig this cellar 3 feet deep at 5 cents a cubic foot? (Scale ½ inch to 2 feet.)

2. How many cubic feet of air in the room of which Fig. 51 is a plan? (Scale ¼ inch to 1 foot.)

3. A room is 20 by 50 feet and 10 feet high. How many cubic

feet of air does it contain? There are 50 children in this room. Each child requires 2,000 cubic feet of air per hour. How many will the 50 children require? Then how long will the air in this room last them? What do we learn from this?

4. What was the answer to question 11 in Lesson VIII? What do we call that many cubic feet? What other name is given it?

5. If 1 cubic yard makes a load, what will it cost to dig a cellar 30 feet long, 20 feet wide and 9 feet deep, at $1.25 a load?

READING LESSON I.

1. When asked to find the cubic inches in a block 4 inches long, 4 inches wide and 2 inches thick, I think of — layers of — rows each, and — cubic inches in a row, or — cubic inches in all.

2. When asked to find the cubic feet in a piece of marble 4 feet each way, I think of — layers of — rows of — cubic feet in a row.

3. When a solid has as many layers as there are rows in a layer, and as many cubic units in a row as there are rows, the solid is a cube.

4. A cube has — equal faces, — equal edges and — corners.

5. In a cubic yard there are — cubic feet. A cubic yard is sometimes called a —.

6. One cubic foot equals — of a cubic yard, and 13½ cubic feet equal — of a cubic yard.

7. A cubic foot contains 12 layers of cubic inches with — rows in each layer, and — cubic inches in each row.

8. There are — — — — cubic inches in a cubic foot.

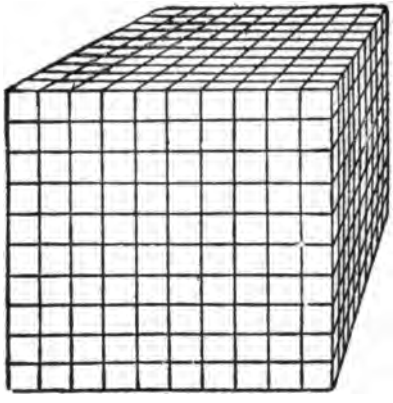
9. A cube 10 inches by 10 inches by 10 inches contains — layers of — rows of — cubic — in a row.

10. A cube 10 by 10 by 10 inches contains — cubic inches.

LESSON X.

NOTE.—The few questions given in these lessons are to suggest the hundreds that may be given as first lessons in decimal fractions.

1. Here is a picture of a cube. How many layers does it contain?



2. How many rows in each layer?
3. How many cubes in each row?
4. How many cubes in each layer?
5. How many cubes in all the layers?
6. One layer is what part of the cube?
7. Two layers are what part of the cube? 3 layers are what part? 4 are what part?
8. Five layers are what part of the cube? What other name can you give 5 layers?
9. Then $\frac{1}{2}$ equals how many tenths?
10. Six layers are what part of the cube? 7 layers are what part? 8 layers? 9 layers? 10 layers?

LESSON XI.

1. One row is what part of the cube?
2. Two rows are what part of the cube?
3. Three rows are what part? 4 rows? 7 rows? 9 rows? 15 rows?
4. Fifteen-hundredths (.15) contain how many tenths?
5. What part of the cube are 25 rows? 36 rows? 48 rows? 96 rows?
6. One little cube is what part of the large cube?
7. Two little cubes are what part of the large cube? 3? 4?
8. What part of the large cube are 5 little cubes? What part are 6 little cubes? 7? 15?

9. One hundred and twenty-five little cubes are what part of the large cube?

10. How many tenths in .125? How many hundredths? How many thousandths?

LESSON XII.

1. If we take .1 of the cube what do we take? (1 layer). If we take .2? If .3? If .7? If .9?

2. If we take .4 of the cube how many tenths are left? How many layers?

3. If .01 is taken what is taken? If .06? If .08? If .25? If .96?

4. If .03 are taken how many hundredths are left? How many layers? How many rows? How many little cubes?

5. When .001 is taken what is taken? (One little cube.) If .002? If .009? If .016?

6. When .846 are taken how many thousandths are left? How many layers are taken?

7. At one time .2 are taken, then .05, then .006; how many are taken? What part is taken?

8. Which is greater, $\frac{1}{2}$, .5 or .50 of the cube?

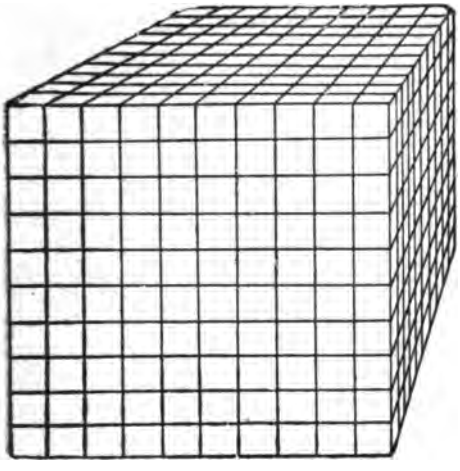
LESSON XIII.

1. One layer is what part of the cube?
2. One row is what part of the cube?
3. One row is what part of 1 layer?
4. One row is what part of what part?
5. Then .1 of .1 equals what?
6. And .1 of .2 equals what?
7. And .1 of .3 equals what?
8. And .1 of .4 equals what?
9. And .1 of .5 equals what?

10. Fill in the blanks. .1 of any number of tenths gives as many ——— as there are ———.

11. What is .3 of .8?

NOTE.—.1 of .8 equals .08 and .3 equals 3 times .08 or 24 ——.



12. How many are .4 of .6?
13. How many are .8 of .9?
14. How many are .7 of .6?
15. How many are .4 of .5?
16. How many are .3 of .1?

LESSON XIV.

1. One little cube is what part of 1 row?

2. One row is what part of the large cube?

3. Then .1 of .01 equals what? (.001.)

4. .1 of .02 equals? .1 of .07 equals?
   .1 of .03 equals? .1 of .08 equals?
   .1 of .06 equals? .1 of .09 equals?

5. Fill in the blanks. One-tenth of any number of hundredths gives as many ——— as we have ———. Never write such questions .5 x .5 but .5 of .5, as they are questions in partition and not multiplication.

6. .3 of .04 equals? .1 of .04 equals ——— thousandth and .3 equal 3 times .004 or .012.

7. .4 of .06 equals?
8. .5 of .08 equals?
9. .9 of .03 equals?
10. .7 of .06 equals?
11. .2 of .08 equals?
12. .3 of .09 equals?
13. .6 of .04 equals?
14. .7 of .08 equals?

NOTE.—See suggestion for teaching division of fractions in "First Lessons in Percentage," page 56.

LESSON XV.

1. Fig. 52 shows the cellar plan of a house. Mr. A was to get $1 a load and the dirt for excavating. If he sold the dirt at 36 cents a load, how much did he receive for the work? 4 feet deep.

2. Fig. 53 is a cellar plan on a scale of ¼ inch to 5 feet. How many cubic yards of dirt will be taken from the cellar if dug 4 feet deep?

3. What would it cost to build the stone foundation of this house, 2 feet thick and 7 feet high, at $18 a cord. (See Note Lesson IX.)

NOTE.—Stone masons have different methods of estimating the cost of building foundation walls. One contractor was asked how he would work it, and he said, "I should throw it into one wall 210 feet long. Then I should have 7 layers of 2 rows, each containing 210 cubic feet. One layer equals 420 cubic feet, and 7 equal 7 times 420 cubic feet, or 2,940 cubic feet. We call 120 cubic feet of *built wall* a cord and get $18 a cord for the stone *in the* wall. Hence 2,940 cubic feet divided by 120 cubic feet equals 24.5, at $18 per cord equals $441. Had the wall been 20 by 40, then the wall would be 120 feet long, and if 1 foot wide and 1 foot thick would have contained 1 cord of masonry. If 2 feet thick 2 cords, and if 7 feet high 14 cords.

4. What would it cost to build a stone foundation 40 feet square, 2 feet thick and 7 feet high, at $18 per cord in the wall?

5. If on the stone foundation of Fig. 53 there was to be built a brick wall 10 feet high and 1 brick thick, how many bricks would it take?

NOTE.—Desiring to know how a bricklayer would find the answer to this question we asked one and he said: "I should think of it as one wall as long as the sum of the four sides, or 210 feet. I should then find how many square feet, the outside surface, such a wall, 10 feet high, would contain. 10 x 210 square feet equal 2,100 square feet. I then estimate that for every square foot I must use 7 bricks, hence 2,100 times 7 bricks equal 14,700 bricks."

"What if the wall was to be 2 bricks thick?" was asked. "I should estimate 15 bricks to each square foot, and if 3 bricks thick I

CHART XXXIII.

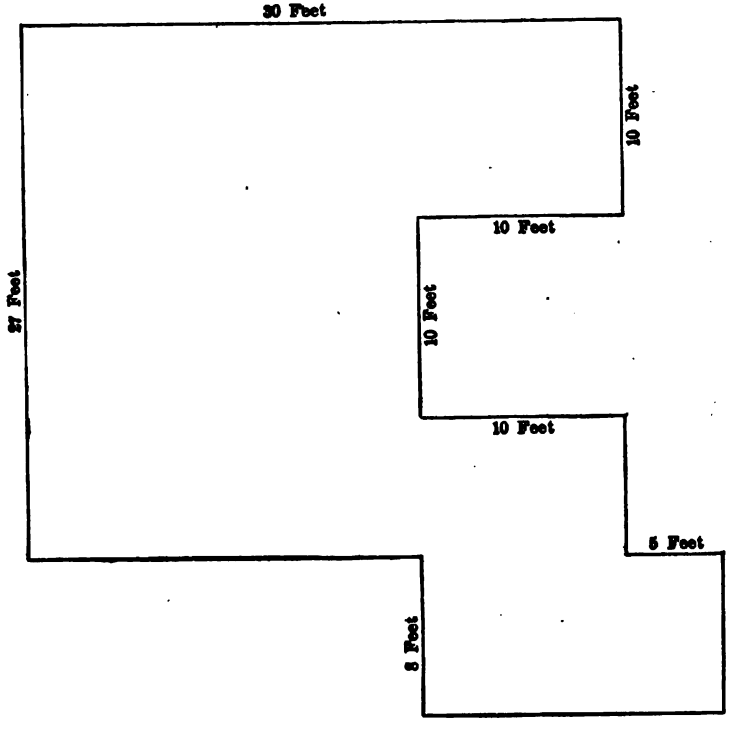


Fig. LII.

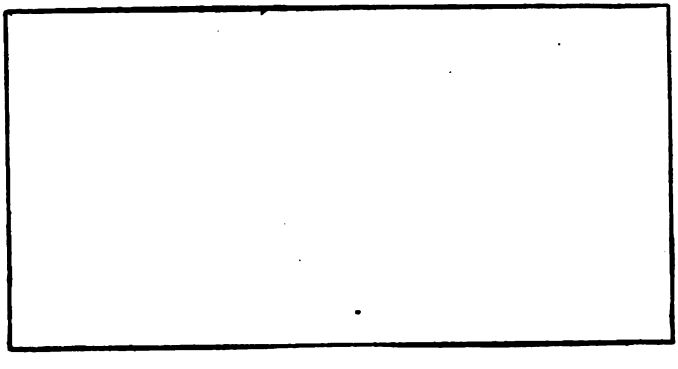


Fig. LIII.

should estimate 22 bricks to each square foot. I should make no allowance for openings unless there were many of them or unless they were very large. I should then deduct 7 times ½ the area of the opening."

6. If a cellar wall were 24 feet square and were 20 feet high, how many bricks would be used in building it 2 bricks thick?

7. How many bricks would be bought to build an ash house 10 feet square and 8 feet high, 1 brick thick?

8. Mr. Williams built a brick wall 17 feet long, 6 feet high and 3 bricks thick. How many bricks did he use?

9. What if Mr. Williams' wall had been made of stone 2 feet thick; how much would it have cost at $18 per cord built?

NOTE.—Where would a stone wall cost the most, in Illinois or Minnesota? Why?

10. At $18 per cord in the wall, what would the stone wall of Fig. 52 cost if 7 feet high and 2 feet thick?

11. If on the stone foundation a brick wall 20 feet high and 3 bricks thick is built, what will the bricks cost at $10 per thousand? There were five openings, each 3 feet wide and 6 feet high.

NOTE.—Remember that a single thing costs as many mills as one thousand cost dollars.

LESSON XVI.

1. Chart 25, Fig. 56 shows a plan of Mr. B's lot. Fig. 57 shows Mr. A's lot. Who had the most land? Why?

2. Then if the north side of B's lot was 13 feet long, the south side 26 feet long, and the west side 26 feet long, what would it cost to dig a cellar 4 feet deep at 81 cents a cubic yard?

3. The first layer of dirt was sold to a man for the top layer of his lawn at $1 a load. What kind of soil do you think it was? Why? What did the contractor get for his job? $79.62 Ans.

4. See Chart 26. Fig. 61 shows the base of a trapezoidal solid 10 inches high. How many cubic inches does it contain?

NOTE.—Here we think of a rectangular solid 3 inches wide, 1 inch thick and 10 inches long.

CHART XXV.

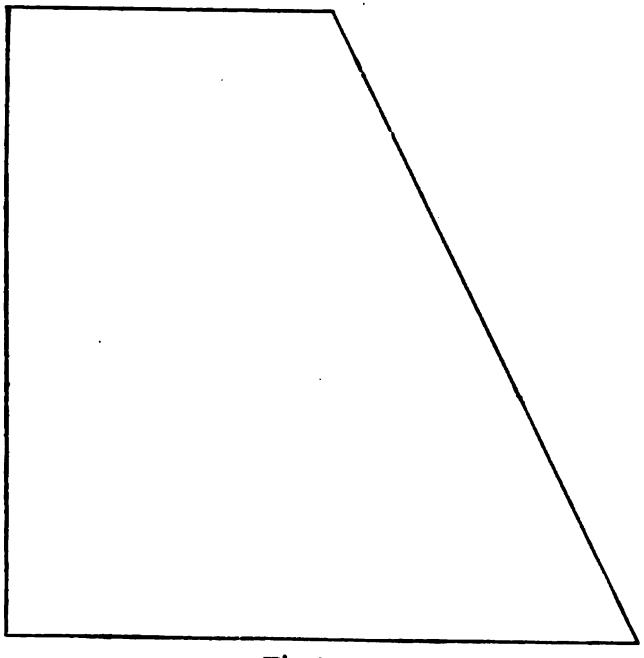


Fig. LVI.

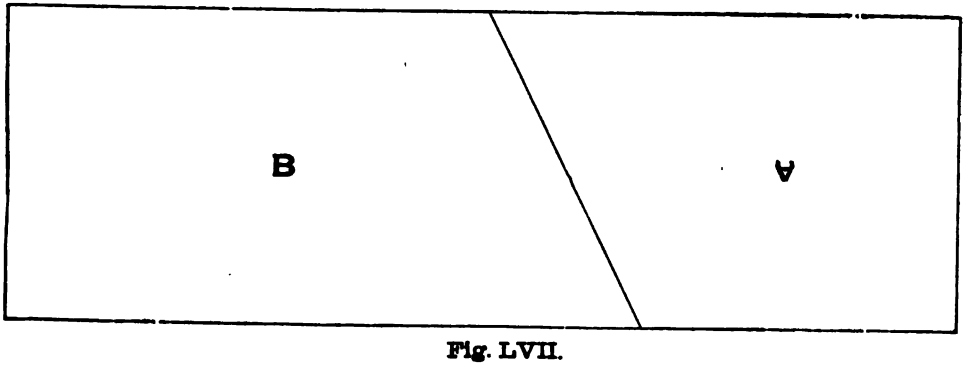
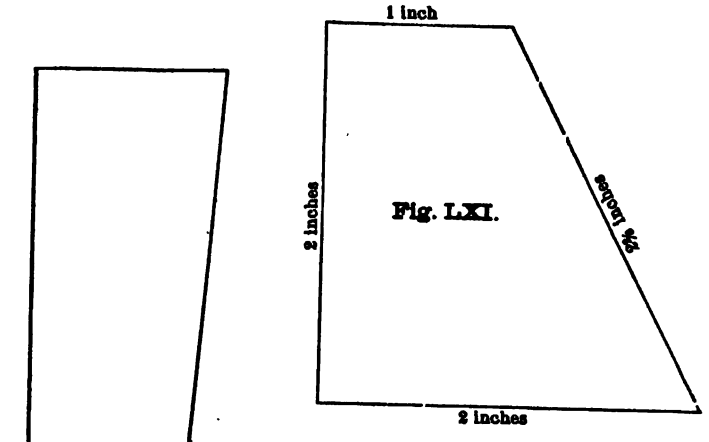
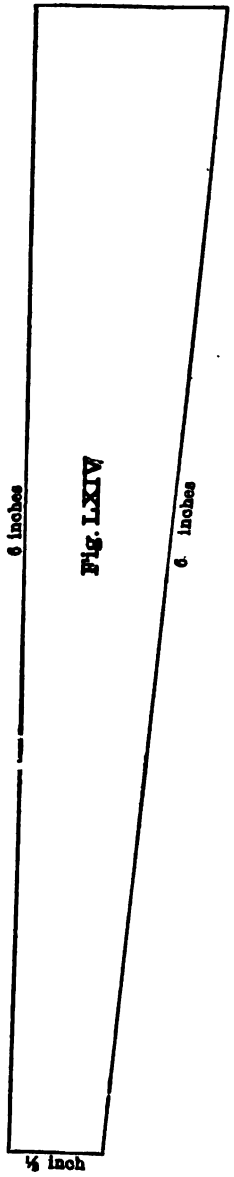


Fig. LVII.

CHART XXVI.


1 inch
2 inches
Fig. LXI.
⅞ inches
2 inches


6 inches
Fig. LXIV
6 inches
½ inch

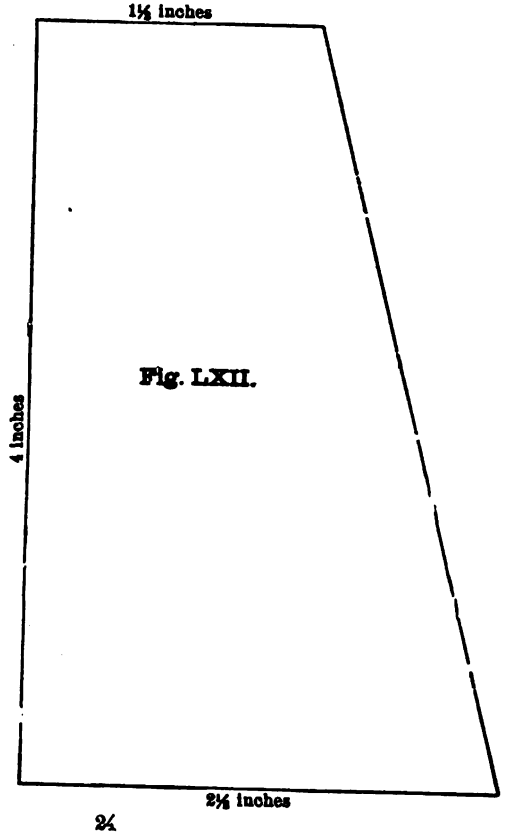

1⅛ inches
Fig. LXII.
4 inches
2⅛ inches

CHART XX.

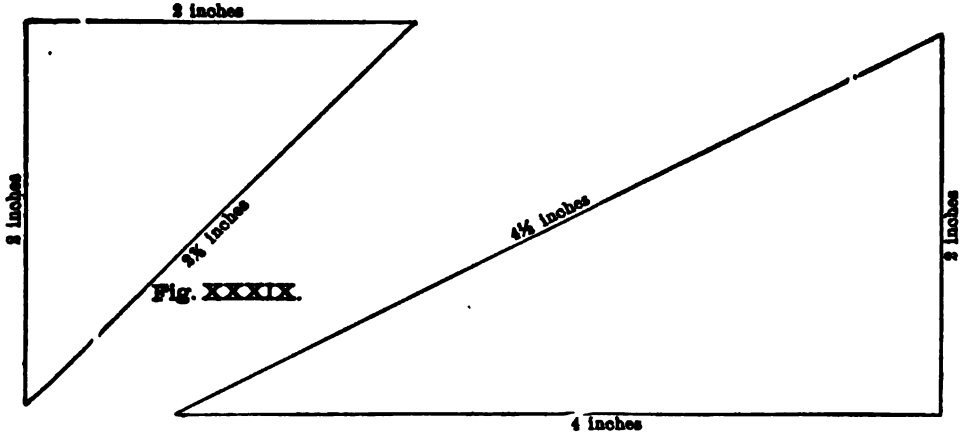


Fig. XXXIX.

Fig. XL.

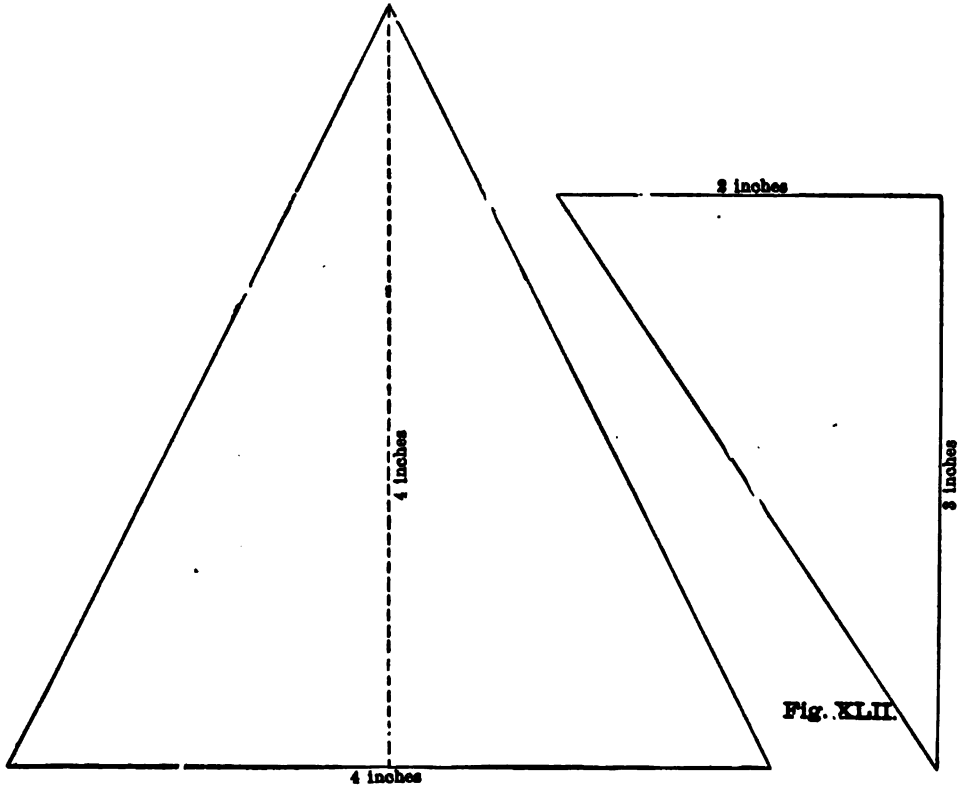


Fig. XLI.

Fig. XLII.

CHART XVIII.

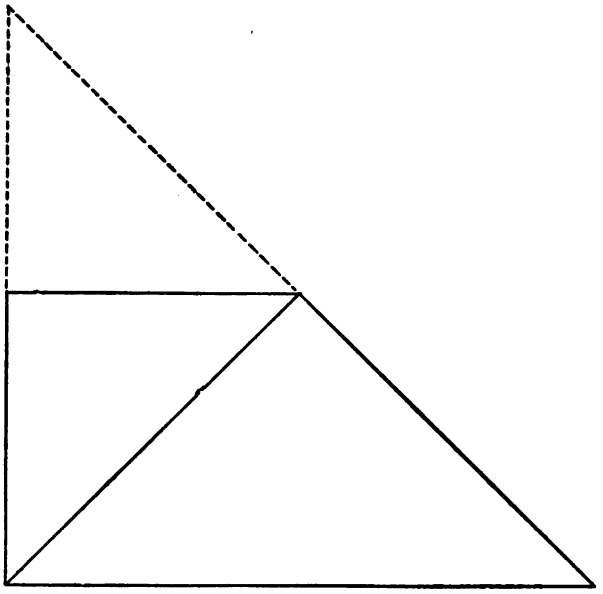


Fig. XXXV.

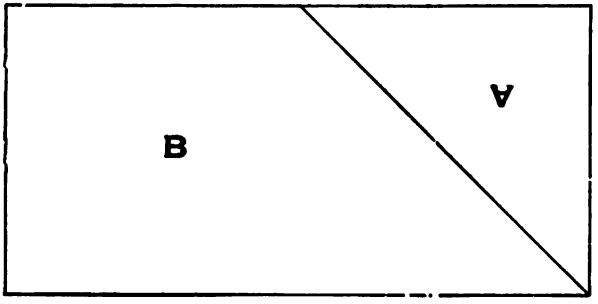


Fig. XXXVI.

5. Fig. 62 shows the base of a trapezoidal solid 21 inches long. How many cubic inches does it contain?

6. Fig. 64 shows the base of one 4 inches long. To how many half-inch cubes is it equal? How many dozen is that?

7. A trapezoidal lot was bounded as follows: Beginning at point A it ran east 25 feet to point B. From B it ran south 80 feet to point D. From D it ran west 45 feet to point C. From C it ran northeast to the place of beginning. If it were excavated to the depth of 3 feet, how many cubic feet were taken from it? (Scale, 1 inch to 10 feet.)

8. When excavating this lot (Ex. 7.) the men found a layer of white sand, and under the layer of sand were a number of fish and shell fossils. What did they tell the men? What if some of them were star-fish fossils?

(See pages 58 and 59 in Area, from which other original questions may be given in Volume.)

LESSON XVII.

1. See Fig. 35, Chart 18, which shows Mr. A's lot, while Fig. 36 shows Mr. B's lot; which one of them had the most land?

2. If the south side of A's lot was 30 feet and the west side was also 30 feet, how many cubic feet of dirt would he take out if he dug a cellar 3 feet deep?

3. See Chart 20 Fig. 39, which shows the base of a triangular prism 10 inches long How many cubic inches does it contain?

4. Fill in the blanks. A triangular prism may be seen as a rectangular solid with its width the same as the base of the triangle, its thickness ——— the altitude of the triangle, and its length the same as that of the ——— .

5. How many cubic inches in a prism 20 inches long whose base is shown by Fig. 40?

6. Fig. 41 shows the base of a prism that had an altitude of 18 inches. How many cubic inches did it equal?

7. Fig. 42 shows the bottom of a dish 10 inches deep, that was filled with water. How many cubic inches of water did it hold?

8. The dish was placed in the window where the hot sun could reach it. In a few days the water was only 9 inches deep. How many cubic inches of water had been taken?

9. The teacher said "Old Sol" took this water. Who was he? Where did he take the water to? How many cubic inches did he let remain in the dish? What part did he take?

(See Area, page 25, for other charts. Also pages 58 and 59.)

10. The three sides of a triangular prism 8 feet long were as follows: the longest side 6 feet and the other two sides each 5 feet long. How many cubic feet did it contain? (Draw the base on a scale of 1 inch to 1 foot. Find the altitude in two ways.)

LESSON XVIII.

1. See Fig. A. Of what is it a picture? How is it divided?

2. See Fig. B. What has been made of the cylinder?

3. Fill in the blanks. A cylinder may be seen as a rectangular solid with its width equal to — — the circumference of the cylinder, its thickness equal to — — the — of the cylinder, and its height or length equal to the — of the cylinder.

4. See Fig. 55. How many cubic feet does it equal?

Tell how wide, thick and high the rectangular solid is that you changed this cylinder to. See **Page 35 in Area.**

5. I have a cylinder whose diameter is 7 feet, and whose altitude is 10 feet. How many cubic feet does it contain?

6. A cylindrical cistern was 7 feet in diameter, and 8 feet deep. How many cubic feet of dirt did it contain?

7. A cylinder that is 21 inches in diameter and 21 inches long contains how many cubic inches?

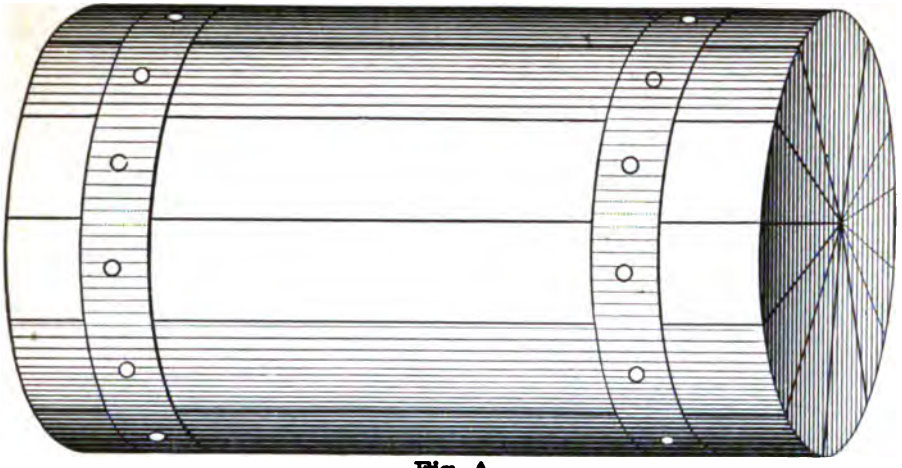


Fig. A

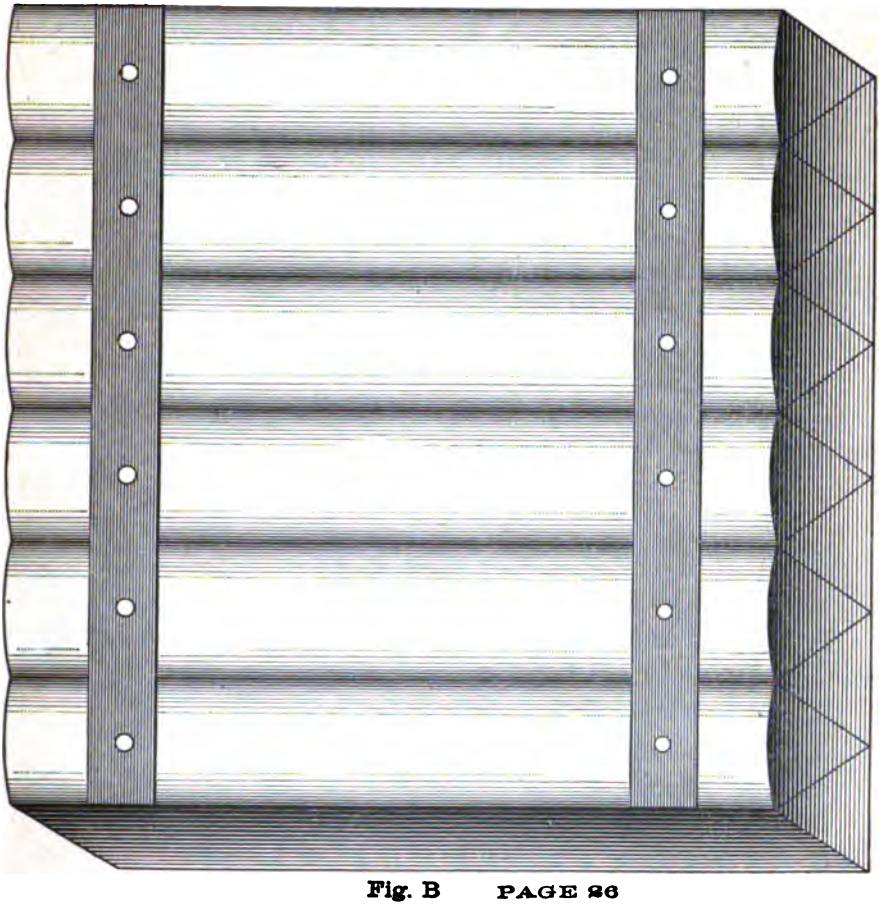


Fig. B

LESSON XIX.

1. A cord of wood is 8 feet long, 4 feet wide and 4 feet high.

NOTE.—By means of a string and 4 sticks each 4 feet long show the class the space which a cord would occupy. After show them a miniature cord. The children should work the following questions without pencils and should see the cord as a unit just as they see the cubic inch, foot or yard as a unit when working a problem in cubic measure.

Let them read the question and give the answer, viz.: A pile of wood 16 feet long, 4 feet wide and 8 feet high contains 4 cords.

2. How many cords of wood in each of the following piles of wood:

4. 16 feet long, 4 feet wide and 8 feet high.
5. 16 feet long, 8 feet wide and 8 feet high.
6. 24 feet long, 4 feet wide and 4 feet high.
7. 24 feet long, 8 feet wide and 4 feet high.
8. 24 feet long, 8 feet wide and 8 feet high.
9. 32 feet long, 4 feet wide and 8 feet high.
10. 40 feet long, 4 feet wide and 12 feet high.
11. 48 feet long, 4 feet wide and 6 feet high.
12. 32 feet long, 4 feet wide and 5 feet high.
13. 64 feet long, 4 feet wide and 10 feet high.
14. 64 feet long, 8 feet wide and 10 feet high.

LESSON XX.

1. How many cords of wood in a pile that is 12 feet long, 4 feet wide and 4 feet high?
2. 24 feet long, 8 feet wide and 6 feet high?
3. 32 feet long, 4 feet wide and 5 feet high?
4. 96 feet long, 12 feet wide and 12 feet high?
5. 80 feet long, 8 feet wide and 5 feet high?
6. 88 feet long, 4 feet wide and 4 feet high?

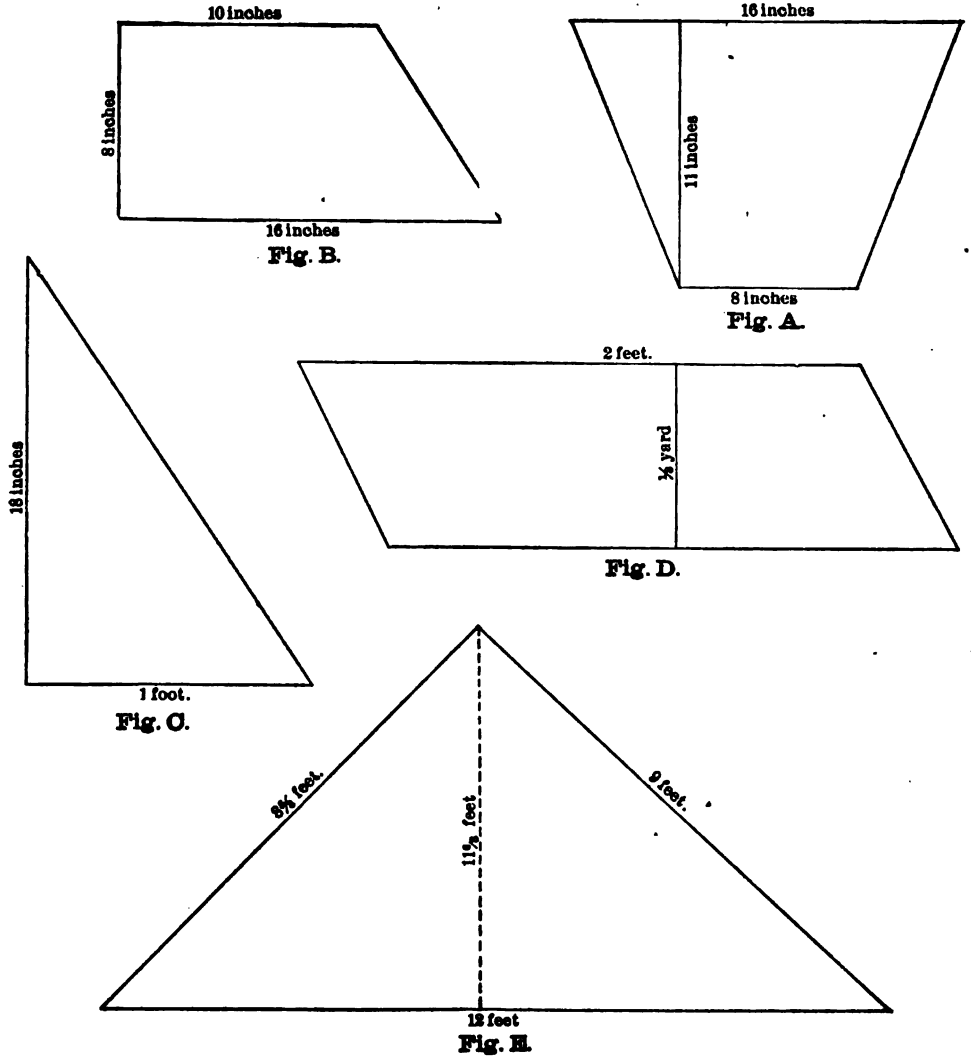


Fig. B.

Fig. A.

Fig. D.

Fig. C.

Fig. E.

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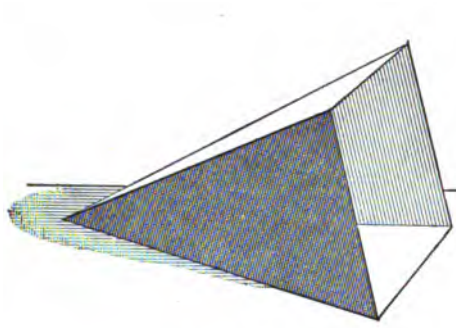


Fig. A

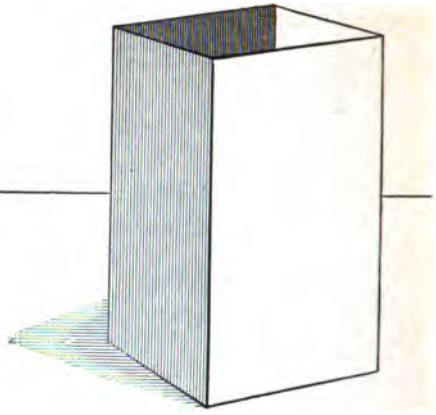


Fig. B

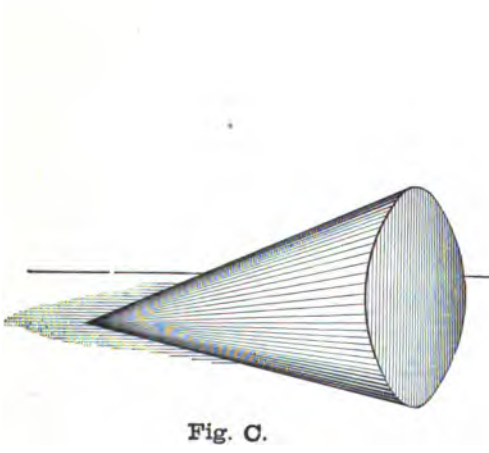


Fig. C.

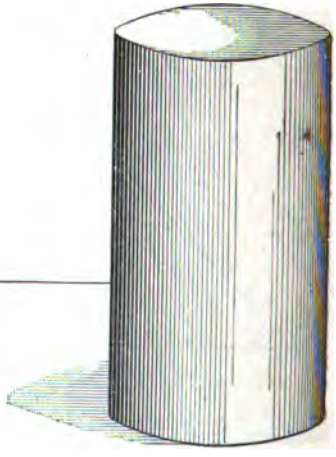


Fig. D.

7. 64 feet long, 4 feet wide and 9 feet high?
8. 32 feet long, 4 feet wide and 11 feet high?
9. 64 feet long, 4 feet wide and 4½ feet high?
10. 48 feet long, 4 feet wide and 4½ feet high?

LESSON XXI.

NOTE.—Take some card-board and cut out four triangles each having a base 3 inches long, and an altitude 5½ inches long. Paste or sew them together, forming a pyramid, whose altitude is 5 inches. (See Fig. A.) Next cut out four rectangles each 3 by 5 inches. Paste or sew them together, forming a rectangular dish. (See Fig. B.) Fill the pyramid with dry sand or wheat and empty it into the rectangular dish. If your work is correctly done it will take just three of them to fill it. Hence a pyramid may be seen as a rectangular solid with a base the same as the pyramid, and an altitude just ⅓ that of the pyramid.

1. Each side of the base of a square pyramid was 4 inches long, and its altitude was 30 inches; how many cubic inches of sand will it hold? How many score was that?

2. A square pyramid with each side of its base 6 inches long, and its altitude 24 inches long, will hold how many cubic inches of water?

3. Where are the largest pyramids in the world to be found? Who built them? How are they divided, and for what purpose? How many loads of dirt in one whose altitude is 60 feet, and each side of whose base is 150 feet?

NOTE.—Make a cone and cylinder of card-board, each having the same altitude and base, and compare them as you did the pyramid. After fill in the blanks. A cone may be seen as a rectangular solid with its width — — the — of the cone's base a thickness — — the diameter the cone's — and an altitude — — that of the cone. See Figs. C and D.

4. A cone has an altitude of 18 inches, and its base is 7 inches in diameter. How many cubic inches of sand will it hold?

5. A conical dish with a base 66 inches in circumference and an altitude of 36 inches is filled with distilled water. How many cubic inches in it? What is the difference between distilled water and spring water? How can you get distilled water?

PART TWO.

BULK.

NOTE.—The gill, pint, quart and gallon measures should be found in every school. The dry quart, half peck, peck and half bushel measure can be made out of card board.

Show the difference between the dry and liquid quart by actual measurements before the class.

Have boxes, bottles, glasses, tin pans, tin cans, etc., of different shapes. Let the children, as a class, judge how much they will each hold and then verify.

For a good review of these measures see First Lessons in Percentage, page 22.

Make of card board, wood, or have made of tin, a box whose inside dimensions are 11 by 7 by 3 inches. Show it to the class.

1. How long is this box?
2. How wide is the box?
3. How deep is the box?
4. How many cubic inch blocks will it hold?

NOTE.—Next show a gallon measure filled level full (if the box is not water-tight) with dry sand or some kind of grain, as wheat or corn.

5. What measure is this? See me pour its contents into the box.
6. What do you discover? Fill in the blank. A gallon contains —— cubic inches.
7. A box that holds 462 cubic inches will hold how many gallons?
8. A box that holds 693 cubic inches will hold how many gallons?
9. A box that holds 1,155 cubic inches will hold how many gallons?

10. A box that holds 2,310 cubic inches will hold how many gallons?

11. A box that holds 1,728 cubic inches will hold how many gallons?

12. What do we call 1,728 cubic inches?

13. A box that will hold one cubic foot of air will hold how many gallons?

NOTE.—For small cisterns and tanks 7.48 may be used. For large reservoirs or lakes and ponds 7.4805 should be used.

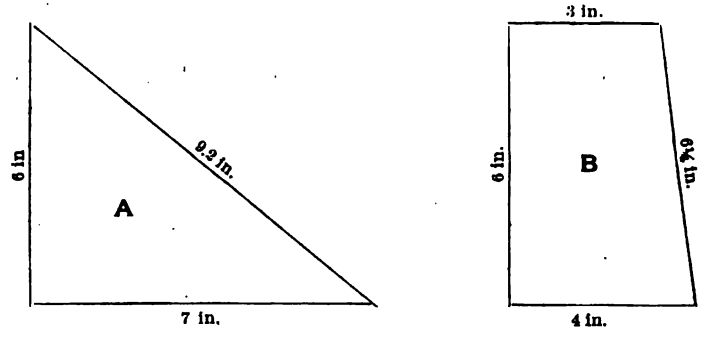
LESSON II.

1. A tank is 5 feet long, 4 feet wide and has 5 feet of water in it. How many gallons is that?

2. A cistern that is 10 feet long, 10 feet wide, and 12 feet deep lacks two feet of being full. How many gallons were in it?

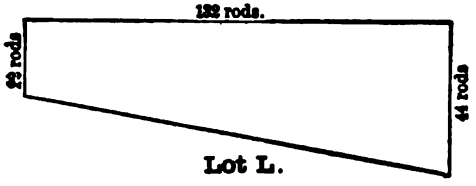
3. A cylindrical cistern 7 feet in diameter ($3\frac{1}{7}$ times the diameter equals the circumference) and 12 feet deep has 10 feet of water in it. How many gallons is that?

4. Figure A shows the base of a dish that is 11 inches deep. How many gallons of water will it hold?



5. Figure B shows the base of a dish that is 22 inches deep. How many gallons will it hold?

6. How many gallons of water in a tank 16 by 24 feet, in which the water is 8 feet deep?



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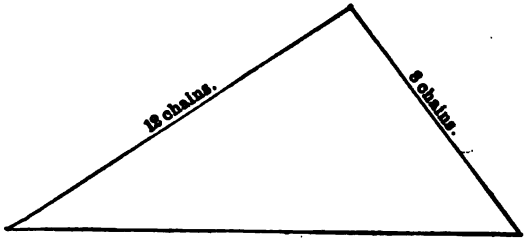

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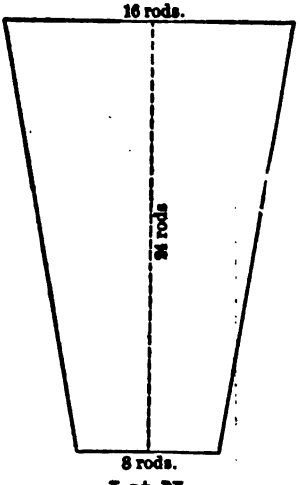

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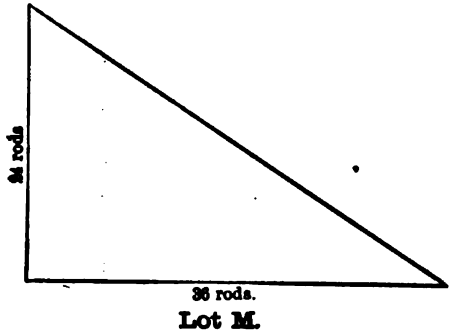

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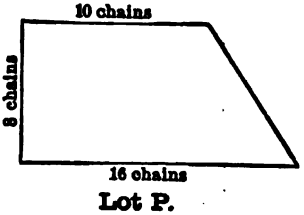

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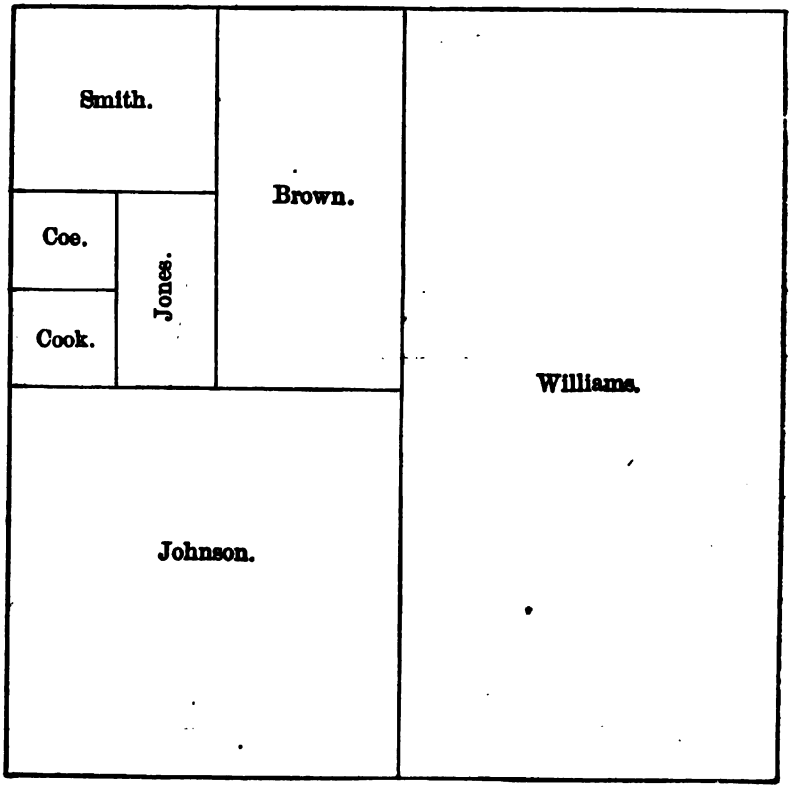


Fig. C.

1 inch to 10 feet.

NOTE.—It is estimated that a box that will hold 1 cubic foot of air will hold about 50 pounds of coal.

7. How many pounds of coal in a bin 5 feet long, 4 feet wide and 3 feet deep? How many tons is that?

8. What was the coal worth at $8 a ton?

9. What will 27 pounds of coal cost at $8 a ton?

NOTE.—Remember that a single thing costs as many mills as a thousand cost dollars. At $8 a ton what will one thousand pounds cost?

10. What will 48 pounds cost at $6 a ton? At $10 a ton?

11. At $20 a ton what will 17 pounds of hay cost?

12. At $40 a ton what will 27 pounds of hay cost?

13. What will the coal in a bin 10 by 5 by 10 feet cost at $7 a ton?

14. At $7 a ton what will 125 pounds of coal cost?

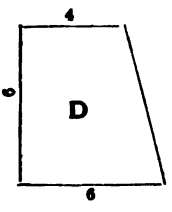
LESSON III.

NOTE.—Most grain is bought and sold by weight. It often happens that a farmer desires to know how much grain he has on hand. It has been found that a box that holds one cubic foot of air will hold nearly .8 of a bushel of grain. To get a general idea of the contents of a bin, then take .8 of the cubic feet it contains.

1. A bin 5 feet long and 4 feet wide had 5 feet of wheat in it. How many bushels is that? 80 Ans.

2. How many bushels in a bin 10 by 4 by 5 feet that is full of corn?

3. The wheat in a bin 12 by 6 by 5 feet was 4 feet deep. How many bushels was that?



4. Fig. D shows the bottom of a box 5 feet deep that was full of corn. How many bushels was that?

5. See Fig. C. Mr. Smith's bin was 10 feet deep and was half full of corn. How many bushels had he?

6. Mr. Coe's bin had 6 feet of wheat in it. How many bushels was that?

7. Jones had how many bushels of oats if his bin was 10 feet deep and was $\frac{3}{5}$ full?

8. Mr. Brown's bin, which was 10 feet deep, was .7 full of rye. How many bushels had he?

9. Mr. Johnson had 1,600 bushels of wheat in his bin. How full was it?

10. Mr. Williams' bin was also 10 feet deep, and was full of coal. About how many tons had he?

MISCELLANEOUS PROBLEMS.

NOTE.—Good drawing lessons can be had here, by requiring the pupils to draw the objects described in the problems.

1. I wanted a glass prism to use in a color lesson. So I took three pieces of glass, two of which were 5 inches by 12 inches, and one 8 inches by 12 inches. I fastened these together with Major's cement. How large a piece of glass is needed for each end? How much more than a quart of water will the prism hold?

2. Joined to the front of the Art Gallery at the World's Fair was a platform of solid masonry. If it was 8 feet high, and 15 feet wide at the base and 10 feet wide at the top, and extended across 100 feet of the building, how many cubic feet of stone were needed for the platform?

3. I have a conical shaped filter 7 inches in diameter and 10 inches deep. I wish to pour in 1 quart of liquid at a time. How much powdered charcoal can I first place in the filter?

4. Our cistern is cylindrical, 14 feet in diameter and 15 feet deep. The filter is the same diameter, but is $\frac{2}{3}$ as deep. It has a layer of charcoal 3 feet deep on the bottom. If the water is within 1 foot of the top of the filter, how many gallons of water are there? How many barrels of 31½ gallons?

5. A bin for holding grain is in the form of a cone. The diameter of the base is 4 feet, the altitude is 21 feet. How many bushels of corn will it contain?

6. The diameter of a cylindrical tank is 56 inches. The altitude is 5 feet. How many gallons of sap will it hold?

7. Mr. A builds a house in which there is a corner chimney; the sides of the triangular base measure respectively 3 feet, 3 feet, and 5 feet; the height of the chimney is 30 feet. How many bricks will be needed to build this chimney one brick thick?

8. A cylindrical-shaped bin has a diameter of the base equal to 14 feet; the height of the cylinder is 20 feet; to the lower end of the cylinder there is attached a cone-like base with a height of 6 feet. How many bushels of wheat will the bin hold?

9. A man has a trapezoidal lot on which he wishes to build a house. The sides are respectively 20, 30, 12, 25 feet; the cellar is to be 4 feet deep. How many cubic yards of dirt will be excavated from such a cellar, and what will it be worth at 50 cents per load?

10. In the above how many feet of stone will it take to build such a cellar wall if the wall extends 3 feet above ground?

11. How many cubic feet of granite in a monument whose shape is in the form of a pyramid with a square base, set upon a pedestal whose base measures 5 feet, height 10 feet, the height of the pyramid being 24 feet?

12. A man dug a cistern 7 feet in diameter and 10 feet deep. He was to get 4 cents a cubic foot and the dirt for digging the cistern. He sold the dirt for 50 cents a load. What did he get for his work?

13. My lawn is 24 feet wide by 50 feet long; the lawn being flat, I wish to raise the back 3 feet above the front and grade evenly. What will it cost me at 12½ cents per cubic foot?

14. The Canadian cheese at the World's Fair was 7 feet in diameter and 10 feet high; if a slice were cut from the center outward 2 feet thick at the circumference, what is the value of the remainder at 12 cents per pound, there being 48 pounds in a cubic foot?

15. One of the smoke stacks on Machinery Hall at World's Fair was 75 feet high, and had a diameter of 4 feet. What was its volume?

16. How many cubic feet did it pour forth in one hour if it emptied itself every 3 minutes?

17. The hopper which holds the grain in the flour mill is 22 feet

in circumference. Its altitude is 4 feet. How many bushels does it hold? Another one is shaped like a pyramid, 4 feet square at the top, and 1½ feet deep. How many bushels will it hold?

18. Mr. A built a corn crib 60 feet long and 20 feet high. It is 3 feet wide at the bottom and 6 feet wide at the top. How many bushels of corn will it hold?

19. He builds another crib of the same dimensions, but ⅓ of it is used for a stairway that leads to the loft above the two cribs. How many bushels of corn will the second crib hold?

20. The loft above is 40 feet wide and 60 feet long. It is 10 feet high from the floor to the highest point in the roof. If 50 % of the loft is used for storing wheat, how many bushels of wheat can be stored in the loft?

21. Mr. A rented a rectangular room, 20 feet by 16 feet, in which to store his grain. As he had both oats and corn, he built a partition running from the northwest corner to the middle of the southern wall. This room was filled with oats 6 feet deep; how many bushels were there?

22. What would be the shape of the rest of the room? If it were filled 7 feet deep with corn, how many bushels were there?

23. How many cubic feet of marble in a pyramid whose base is 20 feet square, and altitude 42 feet?

24. How many cubic feet of air enclosed by a cone of light reflected from a mirror to a wall 18 feet distant, if the base of the cone is 7 feet in diameter?

25. A cistern is 22 feet in circumference and 12 feet deep; how many cubic feet of water will it hold? How many barrels?

26. I once saw in West Virginia a lye-leach for making lye to be used in manufacturing soft soap.

The hopper was shaped like an inverted square pyramid.

If the base of the hopper was 2 feet on each side, and its altitude 4 feet, what was its volume?

27. If the hopper or leach were filled with ashes, how many *bushels* would it hold? Why use ashes? What *kind* of ashes?

28. Had the leach been filled with *water* instead of ashes, how many *gallons* would it have held?

29. Allowing 31½ gallons to the barrel, how many *barrels* of water would this lye-leach have held?

30. A display of chocolate was 2 feet square at the base and 6 feet high in the center.

How much would it cost at 20 cents a pound, weighing ¼ oz. to 1 cubic inch?

How many cups of chocolate could be made of it, reckoning ½ oz. to a cup?

How much would be cleared in selling a cup at 5 cents, if it were bought at 20 cents a pound?

31. The gas tank of the gas works in a city is 70 feet in diameter and when full of gas stands 50 feet high. How many cubic feet of gas have been used by the city during a night, if the tank stands 3 feet high in the morning?

32. The packing of ice in an ice house was almost completed, when a triangular space was found to be left at the corner, which measured 5 feet long, 3 feet wide on the base and an altitude of 2 feet. How many cubic feet of ice and sawdust will it take to fill the required space?

33. A grain box has a base 7 feet long and 6 feet wide. The height of the box at the back is 10 feet, and it stands 8 feet high in front. How large a space is there to be filled with corn?

34. A boiler in a machine shop measures 10 feet in length, with a diameter equal to 42 inches. How many gallons of water will it take to fill the boiler? At the rate of 30 gallons an hour, how many hours will it take to fill the boiler?

35. The ceiling below the roof of a cottage is 20 feet square. The distance from the center of the ceiling to the point of the roof directly above measures 9 feet. How many cubic feet of air will this space contain? In one hour it is estimated that one person breathes 2,000 cubic feet of air. How many minutes will it take for one person to breathe the air in this space? This is what part of an hour?

36. I want to build an ash-box that will hold when filled 462 cubic feet of ashes. If the top of the box is 13 feet long, the bottom 9 feet long, and I make it 7 feet high, how wide will I make it?

37. As a standard for a small statue, a man wishes to make a solid pillar of plaster-of-paris; he wishes it to be 14 inches in diameter and 15 inches high. How many gallons of plaster-of-paris will he use?

38. A jelly mould had a dozen small conical moulds, each with a diameter of $3\frac{1}{2}$ inches, and height of 4 inches. How much jelly will it hold? How many gallons?

39. A man had a room in his home 17 feet square and 11 feet high. He wished to alter it to make it octagonal in shape, so decided to cut off the corners 4 feet from each corner. How many cubic feet of air does he thus sacrifice?

40. A grocer placed in his window a pyramid of oranges 5 feet high and 6 feet square at the base. If nine oranges occupied the space of a cubic foot, how many dozen oranges were there in the pyramid?

41. A man has 18 bushels of grain for which he wants to make a bin in the corner of his barn, which will occupy the least space possible. He finds that a triangular shaped bin will be more convenient than a square one. It can be only 5 feet high, and one side of it can only extend 3 feet from the corner. How long will the other side be?

42. When Robinson Crusoe commenced to write an account of his adventures, he made a pyramid of stones, which enclosed a water-tight apartment for the safe-keeping of his manuscript. This pyramid, when finished, was 4 feet on a side at the base, and 6 feet high, leaving the space of 1 cubic foot for the inner apartment; how many cubic feet of stone in the pile?

43. The butments of a certain railroad bridge are 30 feet long and 8 feet wide on the bottom, 30 feet long 6 feet wide on top, and 24 feet high. Find the pressure exerted by the entire mass, reckoning 160 lbs. to the cubic foot.

44. A farmer wishing to store his potatoes in his cellar, formed a

bin by placing boards 10 feet long across one corner, so that one end of the boards touches the wall 6 feet from the corner. If the bin were 6 feet high, how many bushels would it hold?

45. The citizens of a certain town erected a marble monument to the memory of their deceased mayor. It was in the form of a pyramid, whose base was 16 feet square, and whose altitude was 60 feet. How much did it cost at $2.50 per cubic foot?

46. What is the cost of digging a cistern in the form of a cylinder, whose diameter is 8 feet, and whose depth is 21 feet, at 54 cents per cubic yard? How many gallons of water will it hold?

47. An Indian, squaw and pappoose live in a wigwam 14 feet in diameter at the base and 15 feet high. How long will it take them to breathe the air which it contains once, providing each requires 2,000 cubic feet per hour?

48. The crater of Mt. Etna is an inverted cone. If the altitude is 1,000 ft., and the circumference of the base of the cone 12,000 ft., how much lava could be sent out before overflowing on the sides of the volcano?

Now, a lava stream of triangular shape 1 ft. thick, reaching 15½ miles to the base of the mountain, and 1 mile at the base of the triangle, would be about an average eruption. How much lava is sent out at each eruption? Since the mountain is about 100 miles in circumference at its base, how many such eruptions would it require to add 1 ft. in thickness to the entire mountain? A gorge into the sides of the mountain shows 2,000 such layers; how old, at the least, must Mt. Etna be if one of these eruptions took place every year, although for the last two thousand years there have been eruptions of Mt. Etna once in 25 years?

HOW TO MAKE A CUBIC INCH BOX.

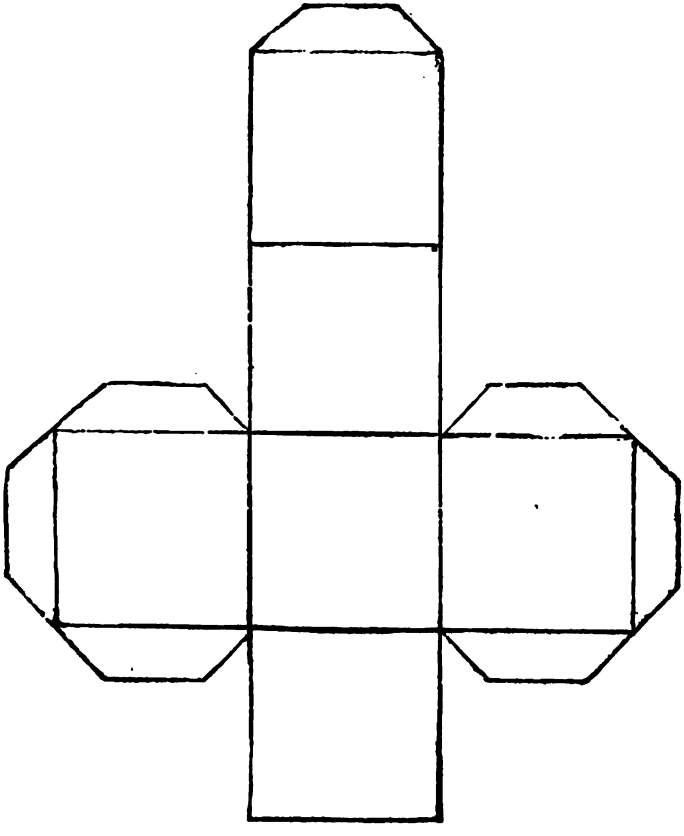
On your papers draw a rectangle 4 inches long and 3 inches wide. Divide the figure into square inches. For convenience, call the row nearest to the back edge of your paper the upper row, the next the middle row and the last the lower row. Find the upper left inch

square. One-fourth inch above and to the left of the lower right corner place a dot. One-fourth inch below and to the left of the upper right corner place a dot. Connect these two dots with a line, and this line with the upper and lower right corners of the square as shown in the cut. Consider the third square in the same manner, only performing the operation on the right edge instead of the left edge of the second square. Consider the lower left and third squares in the same manner. One-fourth inch above and to the right of the upper left corner of the second square in the upper row, place a dot. One-fourth inch above and to the left of the upper right corner of the same square, place another dot. Connect these two dots with a line, and this line with the upper left and right corners of the second square in the upper row as shown in the cut. Consider the second square in the lower row in the same manner, only performing the operation below the lower edge, instead of above the upper edge. One-fourth inch below and to the right of the upper right corner of the fourth square in the middle row, place a dot. One-fourth inch above and to the right of the lower right corner of the same square, place another dot. Connect these two dots with a line, and this line with the upper and lower right corners of the same square. Cut out the figure as shown in the cut. Fold the little trapezoids over on the square to which they are attached. Do not consider the fourth square in the middle row. Fold the four outside squares so that the side edges just touch each other. Now fold the last square over. Paste the little trapezoids to the opposite sides of the squares.

NOTE.—The author questions the wisdom of giving the following rules to grammar children:

It can be proved that the FRUSTUM of a pyramid or cone is equivalent to the sum of three pyramids or cones, which have for their common height the height of the frustum, and whose bases are the lower base of the frustum, the upper base, and a mean proportional between them. Hence the following:

To find the volume of a frustum of a pyramid or cone: *Multiply the sum of the areas of the two bases, plus the square root of their product, by the height, and divide the product by 3.*



1. What is the most familiar example of a frustum of a cone in our school-room? (Country schools.)

2. How many gallons of water will a water-pail hold whose diameter at one end is 12 inches and at the other 8 inches, and whose depth is one foot?

3. A stick of timber was 15 feet long, at one end 18 inches in diameter, at the other 11 inches. How many cubic feet did it contain?

NOTE.—To find the solidity of a sphere. multiply the cube of the diameter by .5236. See note page 50.

How many cubic inches in a cannon ball 6 inches in diameter?

CUBE ROOT.

You may each hold up a cubic inch. Hold up one in each hand. Place the two cubes in a row on your desk.

Place another row behind the first row. How many rows of cubic inches have you? How many cubic inches in each row? How many two cubic inches have you? How many cubic inches?

Place four cubic inches on the first four. How many layers of cubic inches have you? How many cubic inches in each layer? How many four cubic inches have you? How many cubic inches have you?

Show me a two-inch cube. Build a two-inch cube with your inch cubes.

Take an inch cube. On how many sides must you place cubic inches to keep a cube? When you have placed cubes on the three sides, how many have you used?

What kind of a cube have you built? If you place cubes on three sides of this two-inch cube what kind of a cube will you then make? How many layers of cubic inches does the three-inch cube contain? How many rows in each layer? How many cubic inches in each row?

When you have a cube, what relation do you see between the number of layers, the number of rows in a layer, and the number of cubes in a row? Are they *always* the same? If not the same is the solid a cube?

"When I say cube two what do I mean?" "You mean to think of a cube containing 2 layers, of 2 rows of 2 cubes in a row, or 8 cubes in all."

When I say cube three what do I mean? When I say cube eight? When I say nine?

When we have the largest cube each of whose dimensions can be expressed by one figure, how many layers does it contain? How many rows in a layer and how many cubes in a row? 9 ans. How many cubic inches does a cube contain 9 by 9 by 9 inches? (729 ans.) Then the *cube* of the largest number that can be expressed by one figure is expressed by how many figures? (Three.) "Then if I give you the cube of a number as

1,331 what do you know at once?" "That the number cubed was a number expressed with more than one figure. Or we may say its cube root is expressed with more than one figure." "Why?" "Because the cube is expressed with more than three figures."

"What is the smallest number you can express with two figures?" "It is ten." "What is the cube of ten?" "1,000." "What is the largest number you can express with two figures?" "It is 99." "What is the cube of 99?" "It is 970,299."

"How many figures express the cube of the smallest number we can write with two figures?" "Four figures?" "How many figures are used to express the cube of the largest number we express with two figures?" "Six figures." What do you know about the cube root of a number expressed with four, five, or six figures?" "We know its root *must* be expressed with *two* figures?"

"Of what is a number expressed with two figures made up?" "Of tens and units."

"If I tell you a *cube* contains 1,728 cubic inches what do you know?" "We know its cube root (that is the number of layers and rows in a layer and cubes in a row) is expressed with tens and units." "What is the largest ten that the root can contain?" "One." "Why not two?" "The cube of two tens (20) is 8,000."

"If from this cube containing 1,728 cubic inches we take the cube of one ten or 1,000 cubic inches, how many cubic inches will be left?" "1,728 less 1,000 or 728."

"If we place the cube which we have taken out in the center of the table and build cubes around it, on how many sides shall we build?" "On three sides." Let us do this. "How many at least will it take to a side?" "100 to a side and for the three sides, 300." Have we used all the cubes?" "No there were 728 and we have used but 300." "If it takes 300 cubes to go once around how many times can we go around with 728?" "As many times as there are 300 cubes in 728 cubes or 2 at least." "Let us try and see. On one side, say the front, we will use how many?" "There will be ten layers of 2 rows and 10 cubes in a row, or 200." "Now on the side how many will it take?" "There will be ten layers of 2 rows and *twelve* cubes in a row, or 240

cubes." "Next, on top, how many will it take?" "There will be *two* layers of 12 rows of 12 cubes in a row, or 288 cubes." "How many cubes have we used?" "200+240+288=728." "How many had we?" "Just 728." "Then what must have been the unit's figure of the root?" "We have proved that it ***must be two.***" "What is the cube root of 12,167?"

```
        12,167(23
         8,000
1,200)   4,167
         1,200
         1,380
         1,587
         4,167
```

The cube contains *five* figures. The root ***must*** contain *two* figures. The largest ten it ***can*** contain is 2. A cube 2 tens long (20) contains 8,000 cubes. Take this from the large cube (12,167 less 8,000) and there remain, 4,167 cubes. To build these around the tens cube once we shall use at least 1,200 cubes and by dividing (4,167÷1,200) we find we can go around 3 times; using on the front, 20 layers of 3 rows of 20 cubes in a row, or 1,200. On the side, there will be 20 layers of 3 rows of 23 cubes in a row, or 1,380. On the top, there will be 3 layers of 23 rows of 23 cubes in a row, or 1,587, or in all 4,167, just what we had left, hence we know the unit's figure of the root is 3.

NOTE.—To find the solid contents of a sphere we may think of a rectangular solid, with its length and width equal to the diameter of the sphere, and its thickness equal to one-half the sphere's diameter. This is sufficiently accurate for all practical purposes, as may be proved by using a rubber ball, filling it with water and then emptying it into a rectangular dish, as above.

FIRST LESSONS

IN

PERCENTAGE

BY

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HOW NOT TO TEACH, ETC.

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CHICAGO.

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1894.

DEVELOPMENT LESSON.

"I have here an apple. What do we call this outside part?" "The peeling." "If I take one-half of the apple thus, what part of the peeling do I take?" "You take — half of it." "What part of its juice do I take?" "— of it." "What part of everything it contains that is equally distributed?" "One — of it." "Then what part of its halves do I take?" "One-half of its halves." "What part of its thirds?" "One — of its thirds." "What part of its fourths?" "—of its fourths." "What part of its eightieths?" "One — of its ——." "What part of its hundredths?" "One-half of — ——."

"What is this in my hand?" "It is a knife." "Would they call it a knife in Germany?" "—." "What would they call it?" "They would call it a *messer*." "Would it be the same knife?" "Yes." "Then why would they not call it a knife?" "Because they live in a country where they speak a different language." "True, so is it with us now in our Arithmetic. We are about taking up a new department, and will use a different language for some things. We have said, till now, when any thing was divided into one hundred equal parts, that each part was $\frac{1}{100}$ of it, and that all of it was $\frac{100}{100}$. Hereafter, when speaking of $\frac{100}{100}$ of any thing we shall say 100 per cent. And when speaking of $\frac{1}{100}$, $\frac{2}{100}$, $\frac{3}{100}$, etc., we shall say 1 per cent, 2 per cent, 3 per cent, etc. Then, an apple has how many halves?" "It has two one halves." "How many thirds?" "It — — — ——." "How many per cent?" "It has — per cent."

"We say the apple has two halves, three thirds, four fourths, $\frac{100}{100}$ or 100 per cent. Then if I take one-half of it, I take how much of its thirds? Its fourths? Its 100 per cent?" "One-half." "What is its whole per cent?" "100 per cent." "Then what is one-half of its per cent?" "One-half of 100 per cent, or 50 per cent."

How many halves has any thing? (Let the pupils read and give

the answer to each question.) How many thirds? How much per cent? Then if we take one-half of any thing, what per cent do we take? If we take one-third of any thing, what part of its per cent do we take? "What is one-third of any thing's per cent?" (One-third of 100 per cent, or 33⅓ per cent.) "Then one-third of any thing is what per cent of it?" "33⅓ per cent."

SUGGESTIVE QUESTIONS ON CHART I.

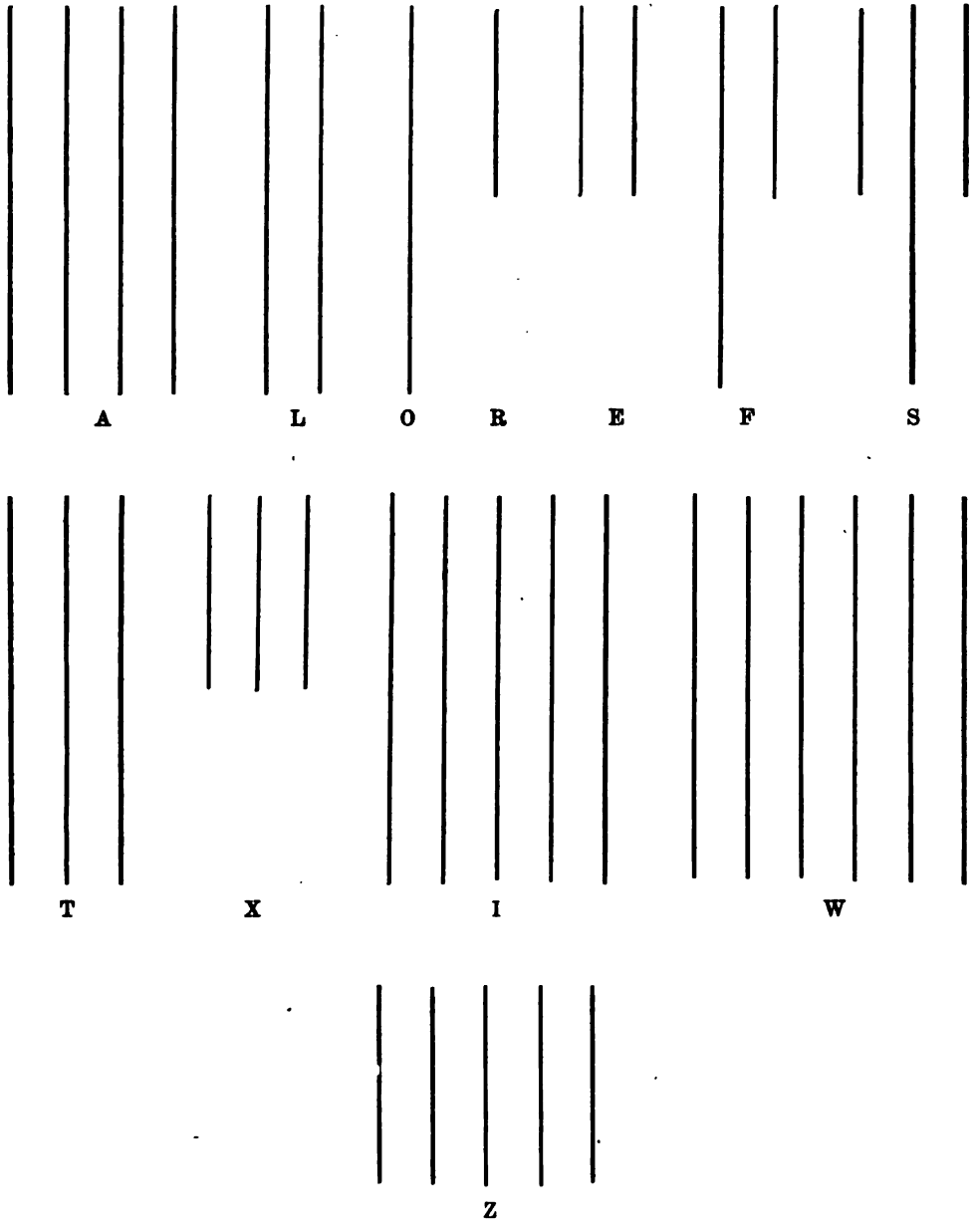
NOTE.—To answer these questions, first ask *what part.* As soon as this is found, the per cent is known. Ex. L equals what part of A? "One-half of it." Then it equals 50 per cent of it.

1. L equals what per cent of A?
2. O equals what per cent of A?
3. R equals what per cent of A?
4. E equals what per cent of A?
5. F equals what per cent of A?
6. S equals what per cent of A?
7. T equals what per cent of A?
8. X equals what per cent of A?
9. O equals what per cent of T?
10. R equals what per cent of T?
11. L equals what per cent of T?
12. To what per cent of E plus F is R equal?

NOTE.—To *what part* of E plus F is R equal? "To one-fifth." Then 20 per cent is the answer. Remember to ask the question, "*What part.*"

13. To what per cent of F plus S is R equal?
14. R equals what per cent of T plus X?
15. R equals what per cent of A plus O?
16. R equals what per cent of I?
17. R equals what per cent of W?
18. To what per cent of W plus X plus Z is R equal?

PERCENTAGE CHART. I.

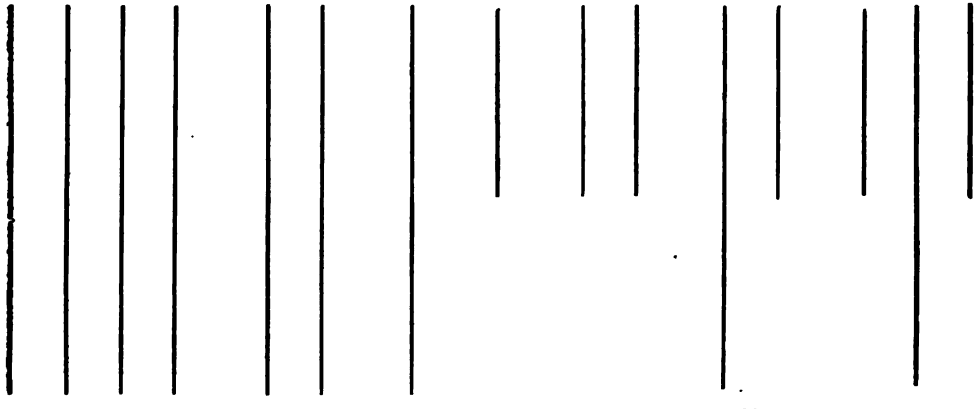


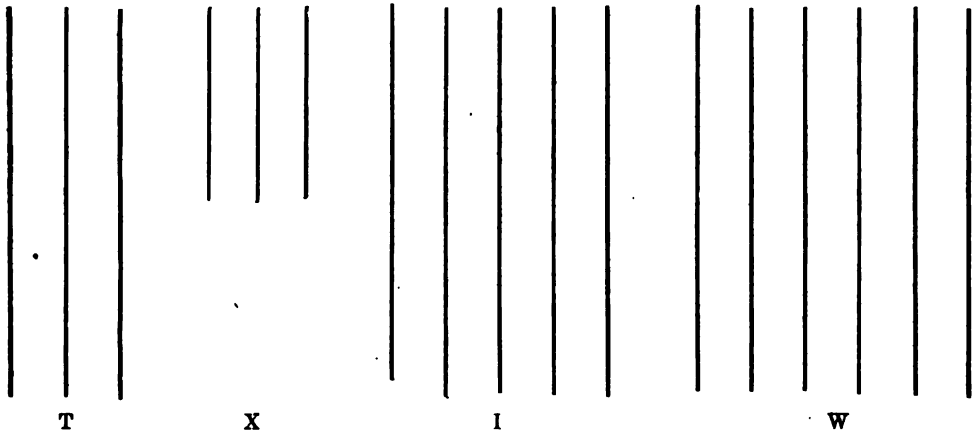
19. 50 per cent of T is equal to what per cent of F?
20. 20 per cent of I is equal to what per cent of O?
21. 16⅔ per cent of W is equal to what per cent of I?
22. 33⅓ per cent of T is equal to what per cent of A?
23. Add X to T and what per cent do you increase T? What X?
24. Add O to I and what per cent do you increase I? Next take it away again and what per cent do you diminish the sum?
25. F equals what per cent of I?
26. F equals what per cent of W?
27. F equals what per cent of Z?
28. Thirty per cent of I equals how many of its lines?
29. Twenty per cent of Z equals how many of its lines?
30. Take 66⅔ per cent of T and how many are left?
31. Take 75 per cent of A and how many are left?
32. Take 40 per cent of Z and how many are left?
33. Take 8⅓ per cent of W and how many are left?
34. W is 50 per cent more than what group?
35. I is 16⅔ per cent less than what group?
36. A is 33⅓ per cent more than what group?
37. A is 20 per cent less than what group?
38. Add 25 per cent of A to 33⅓ per cent of T and how many have you?
39. Add 16⅔ per cent of W to 20 per cent of I and how many have you?
40. To 50 per cent of E add 50 per cent of O and the sum is equal to what per cent of W? Of I? Of Z?

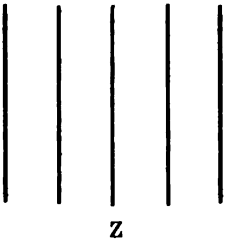
SUGGESTIVE QUESTIONS ON CHART II.

1. A equals what per cent of B?
2. B equals what per cent of A?
3. M is what per cent of B?

PERCENTAGE CHART. I.







Why may we say *is* here, and not in numbers one and two, where we say *equals?*

4. O is what per cent of F?
5. R is what per cent of I?
6. W is what per cent of L?
7. R equals what per cent of W?
8. R equals what per cent of M?
9. S equals what per cent of W?
10. L equals what per cent of A, B, L?
11. R is what per cent of I plus M?
12. A is what per cent of A, B, F, I and L?
13. S is what per cent of L plus M?
14. O is what per cent of F plus M?
15. S equals what per cent of A plus R?
16. X equals what per cent of A plus F plus W?
17. What equals 50 per cent of M?
18. What equals 25 per cent of L?
19. What equals 50 per cent of S?
20. What equals 12½ per cent of F?
21. What equals 33⅓ per cent of F?
22. What equals 50 per cent of X? (One-half of W, Ans.)
23. What equals 100 per cent of B?
24. Of what is R 12½ per cent?
25. Of what is X 25 per cent?
26. We will call A, B, F, I, and L, pies. M is one-half per cent of my pies; how many have I?

NOTE.—I must have 100 per cent. If M is one-half per cent, then one per cent must be two Ms, or one pie, and 100 per cent must be 100 times 1, or 100 pies.

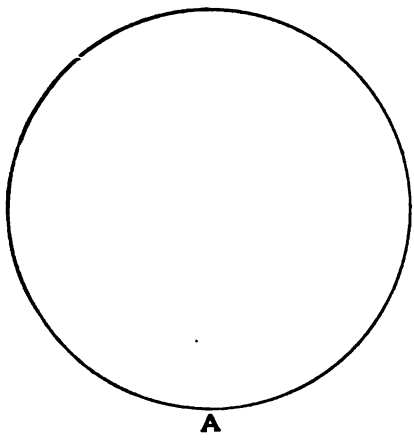
27. R is one-fifth per cent of my pies. How many pies have I?

NOTE.—I must have one hundred per cent. If R is one-fifth per cent, then one per cent must be 5 Rs or five-fourths, and 100 per cent must be 100 times five-fourths, or $\frac{5}{4}\frac{0}{0}$ equals 125 pies.

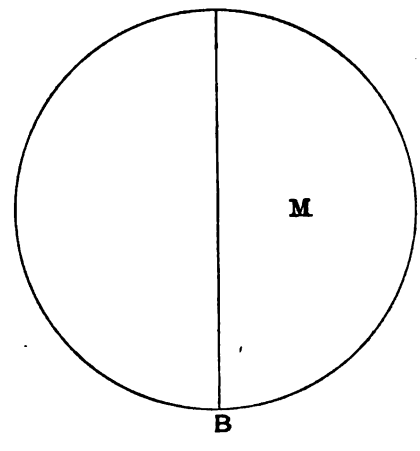
28. D is one-third per cent of my pies. How many have I?
29. W is one-half per cent of my pies. How many have I?
30. X is one-fifth per cent of my pies. How many have I?

PERCENTAGE

CHART II.



A



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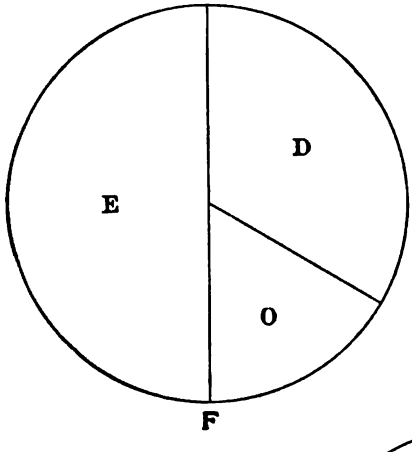
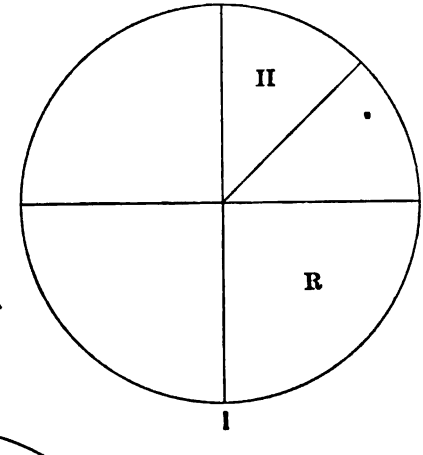


F



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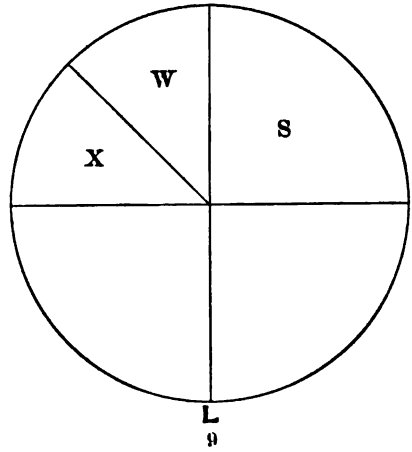


L

31. I have 50 pies, and give John one-third per cent of them. Which piece was that?

32. I had 50 pies, and gave John, May and Will each one-fourth per cent of them. Which pieces was that?

33. S equals what per cent of D?

NOTE.—Here we have the question, one-fourth equals what part of one-third? To compare these we must make them *like things*, as only like things can be compared. One-quarter equals three-twelfths, and one-third equals four-twelfths. Now we ask, three-twelfths equals what part of four-twelfths, or 3 equals what part of 4, and the answer is three-quarters, hence 75 per cent is the answer.

34. H equals what per cent of D?

35. O equals what per cent of R?

36. D equals what per cent of M?

NOTE.—Few, if any, problems here given require the use of a pencil.

PROBLEMS.

LESSON I.

To be read by the pupils as a class exercise. When read, they are to tell what is given, what is required, and how they obtain an answer to the question. Examples.—(1) John had $4, and spent 50 per cent of it; how much did he spend? We have given 100 per cent, or all of John's money, and are required to find 50 per cent of it, or one-half of it. If John spent 50 per cent of $4, he spent one-half of it, or $2.

2. William has 3 apples, which equals 33⅓ per cent of what he had yesterday. How many had he yesterday? We have given 33⅓ per cent, and are required to find 100 per cent. If 3 apples are 33⅓ per cent, they must be one-third, and if 3 are one-third, three-thirds will be three threes, or 9 apples.

3. Henry has 6 cents, which equals 50 per cent more than May has. How many cents has May? We have given what is equal to 150 per cent of May's money, or three-halves, and are required to find 100 per cent, or May's money. If 6 cents are 150 per cent, they are three-halves. If 6 cents are three-halves, then one-half (or one part) will be one-third of 6 cents, or 2 cents, and two-halves, or the whole of May's money, will be two 2 cents, or 4 cents.

4. John has 12 marbles, which are 33⅓ per cent less than he had last week. How many had he last week? We have given 66⅔ per cent, and are required to find 100 per cent. If 12 marbles are 33⅓ per cent *less* than what he had, they must be one-third less. The whole must have been three-thirds, and three-thirds less one-third equals two-thirds. Then 12 is two-thirds. One-third (or one part) is one-half of 12, or 6, and three-thirds equals 3 times by 6, or 18.

5. George bought a ball for 6 cents and sold it for 9 cents. What per cent did he gain on the money invested? We have given the cost and the selling price, and are required to find the per cent gained on the cost. If George paid 6 cents for a ball and sold it for 9 cents, he gained the difference between 9 cents and 6 cents, or 3 cents. Three cents equal one-half of 6, and one-half of anything is 50 per cent of it.

6. Fred paid 12 cents for a knife and sold it for 9 cents. What per cent did he lose on the money invested? We have given 100 per cent, or the cost, and the selling price, and are required to find the per cent lost. If Fred paid 12 cents and sold for 9 cents, he lost the difference between 12 cents and 9 cents, or 3 cents. Three cents equal one-fourth of 12, and one-fourth of anything is 25 per cent.

7. Thomas had 8 apples and gave 50 per cent of them to William. How many did William get? We have given — per cent, and are required to find —. If Thomas had 8 apples and gave William 50 per cent of them, he must have given — of them, or — apples.

8. May had 9 pins at noon, being only 33⅓ per cent of what she had in the morning. How many pins had she in the morning? We have given — per cent, and are required to find — per cent. If May had 9 pins and these were but 33⅓ per cent of what she had in the

morning, they must be only — of them, and if 9 is — of them, $\frac{1}{3}$ or the whole will be —, or — pins.

9. Lizzie had 16 cents on Tuesday, which were 33⅓ per cent more than she had on Monday. How many cents had she on Monday? We have given 133⅓ per cent and are required to find — per cent. If 16 is 33⅓ per cent more, they must be equal to —, and if 16 are $\frac{4}{3}$, then — (or one part) will be — of 16 or —, and — or the whole will be —, or 12.

10. Jennie had 18 buttons on a string, which were 33⅓ per cent less than she had at first. How many had she at first? We have given — per cent, and are required to find —. If 18 are 33⅓ per cent less, then they must be — per cent, and — per cent of anything is — of it. If 18 are $\frac{2}{3}$, then — will be — of 18, or —; and —, or the whole, will be —, or —.

11. A man paid 9 cents for a doll, and sold it for 12 cents. What per cent did he gain? We have given — and the — prices, and are required to find the per cent gained. If the doll cost 9 cents and sold for 12 cents, the gain was the difference between — and —, or —, and — cents is — of 9 cents, and — of anything is — per cent of it.

12. Mary had 15 cents when she went to the store, and but 10 cents when she returned. What per cent of her money did she leave at the store? We have given —, what is left of 100 per cent, and are required to find what per cent was left at the store. If Mary had 15 cents and brought back 10 cents, she left the difference between 15 cents and 10 cents or —, and — is — of 15, and — of anything is — of it.

LESSON II.

NOTE.—If thought best the answer only may be given. As B has $36 and pays 33⅓% of it for a coat, what did the coat cost? $12. Now and then a pupil may be required to give reasons for his answer.

13. B has $36 and pays 33⅓ per cent of it for a coat. What did the coat cost him?

14. Mr. Smith paid $20 for a cow. What per cent of his money did he pay for her if he had $40?

15. I sell a horse for $60 and gain 33⅓ per cent by doing so. What did the horse cost me?

16. I sell a horse for $60, and lose 33⅓ per cent by doing so. What did the horse cost me?

17. Buy goods for $10 and sell them for $15. What per cent do I gain?

18. Buy goods for $20 and sell them for $10. What per cent do I lose?

19. Mr. Edwards sells goods so as to gain $11, which were 33⅓ per cent. What did the goods cost?

20. Mr. Gilmot sells goods so as to lose $8, which were 50 per cent of the cost. What did he pay for the goods?

21. Two boys each had 24 cents. The first spent 50 per cent of his portion, and the second spent 33⅓ per cent of his. How much did they each spend?

LESSON III.

22. NOTE.—*If I take one-fourth of an apple, what part of its peeling do I take? One-fourth. What part of its per cent do I take? One-fourth of its per cent. What is one-fourth of its per cent? One-fourth of 100 per cent, or 25 per cent. One-fourth of anything is what per cent of it? 25 per cent of it.*

23. Four tops are 25 per cent of Will's tops. How many tops has he?

24. A farmer had 16 bushels of corn, and sold 25 per cent of it. How many bushels did he sell?

25. A grocer sold some rice for $20, which was 25 per cent more than it cost him. What did it cost him?

26. Another grocer sold some rice for $30, which was 25 per cent less than it cost him. What did it cost him?

27. Mr. Whitney gave his son $6, which was equal to 25 per cent of what he gave his daughter. What did he give his daughter?

28. Twenty-five books are 25 per cent of how many books?

29. A gentleman had $80, and gave 25 per cent of it to an orphans' school. How much did he give the school?

30. A lady had $66, and gave 33⅓ per cent of it to the Home for the Friendless. How much did she give to the home?

31. A clerk gets $39 per month and pays 33⅓ per cent of it for his board. What does his board cost him?

32. A little boy had 8 cents, and he earns 100 per cent more. How much does he then have?

33. Mr. Williams gave $30 to The Poor Boys' Night School. If this were 25 per cent of his money, how much money had he?

34. Mrs. Williams had 40 bushels of apples. She sold them for $2 per bushel, and then gave 25 per cent of the money to the same school. How much did she give to the school?

35. Mr. Woodside had $90 and gave 50 per cent of his money to the Newsboys' Home. How much did he give the home?

LESSON IV.

36. *Note.—"If I give one-fifth of anything away, what part of its per cent do I give?" "You give — of its per cent." "What is one-fifth of its per cent?" "It is one-fifth of — per cent, or — per cent." "Then one-fifth of anything is what per cent of it?" "One-fifth of anything is 20 per cent of it."*

37. Frank gave me 5 marbles, which were 20 per cent of all he had. How many did he have? We have given 20 per cent. Required to find — per cent. If 5 are 20 per cent, they must be — of the whole number, and if 5 are —, then five-fifths or the whole will be — times —, or —.

38. If $10 are 20 per cent of my money, how much money have I?

39. If $36 are 20 per cent more than my money, how much money have I?

40. If $48 are 20 per cent less than my money, how much money have I?

41. C buys a hat for $5 and sells it for $6. What per cent does he gain?

42. I buy goods for $33 and sell them for $44. What per cent do I make?

43. B buys goods for $45 and sells them for $54. What per cent does he make?

44. C buys goods for $52 and sells them for $65. What per cent is gained?

45. Mr. Wilmington buys goods for $40 and sells them for $60. What is his gain, per cent?

46. Smith, Brown & Co. pay $12 for sugar and sell it for $24. What per cent do they gain?

47. Twenty dollars are what per cent of $50? What per cent of $60?

LESSON V.

48. NOTE.—"If I give $\frac{1}{6}$ of my orange away, what part of its 100 per cent do I give away?" "You give — of its 100 per cent away." "What is $\frac{1}{6}$ of 100 per cent?" "$\frac{1}{6}$ of 100 per cent is $16\frac{2}{3}$ per cent." "Then $\frac{1}{6}$ of anything is what per cent of it?" "$\frac{1}{6}$ of anything is — per cent of it."

49. I hold in my left hand 7 cents, which are equal to $16\frac{2}{3}$ per cent of what I hold in my right hand. How much do I hold in my right hand? We have given — per cent, and are required to find — per cent. If 7 cents are equal to $16\frac{2}{3}$ per cent, they must be equal to — of it, and if 7 cents are —, the whole or — will be — times 7 cents, or —.

50. The captain of the club kicked a foot-ball 21 feet, which were $16\frac{2}{3}$ per cent farther than one of the other boys kicked it. How far did the other boy kick it?

51. The short-stop threw a ball 80 feet; this was $16\frac{2}{3}$ per cent less than the first-baseman threw it. How far did the first-baseman throw it?

52. Buy a ball for 12 cents and sell it for 14 cents. What per cent do I make?

53. Two-sixths of anything are what per cent of it?

54. I pay 6 cents for a tip-top top and sell it for 11 cents. What is my gain per cent?

55. It costs Mr. Henrying $\frac{5}{6}$ of his salary to live. What per cent of his salary is that?

56. A merchant sold 20 yards of cloth, which were 16$\frac{2}{3}$ per cent of the whole piece. How many yards were there?

57. A gentleman had $1 and earned one more. What per cent did he increase his money? He then earned $1 more. What per cent did he increase the second amount? Again he earned another $1. What per cent did he then increase his third amount? Next he spends $1. What per cent does he diminish his money?

58. Willie has 5 cents. His mother gives him 1 cent more. What per cent is his money increased? He then spends 1 cent. What per cent does he diminish his money?

59. A boy had two piles of apples. In the first pile there were 12 and in the second there were 2. He took 2 apples from the first pile and put them on the second pile. What per cent did he diminish the first pile, and what per cent did he increase the second?

60. He again took 2 from the first and added them to the second. What per cent was the first pile diminished, and what per cent was the second pile increased?

61. Sell goods that cost $6 so as to make a profit of $5. What per cent did I make?

62. NOTE.—"If I have 7 cents and give away one of them, what part of my money do I give away?" "You give — of it." "Then what part of its per cent do I give?" "You give — of its per cent." "What is — of its per cent?" "— of its per cent is — of 100 per cent, or 14$\frac{2}{7}$ per cent." "Then one-seventh of anything is what per cent of it?" "One-seventh of anything is — per cent of it."

63. A set of Dickens' works that cost $21 were sold for $24. What per cent was made on the money invested?

64. A house is rented for $850 per year, which is $14\frac{2}{7}$ per cent of its cost. What did the house cost?

65. A parlor set was sold for $64, which was $14\frac{2}{7}$ per cent above cost. How much profit was that?

66. A farmer sold two horses for $48 each, gaining $14\frac{2}{7}$ per cent on one and losing $14\frac{2}{7}$ per cent on the other. What was lost or gained by the transaction? (Answer, $2.)

67. I sold two cows for $60 each, gaining 20 per cent on one and losing 20 per cent on the other. What was the gain or loss per cent on the whole transaction? What had I lost but $14\frac{2}{7}$ per cent?

68. A stove dealer pays $49 for a stove, and sells it at a profit of $28\frac{4}{7}$ per cent. What does he receive for the stove?

69. Lillie has 7 cents, and her father increased it to 10 cents. What per cent did he increase it?

70. Five tons of coal were sold for $24, which was a loss of $14\frac{2}{7}$ per cent. What did the coal cost?

71. A father had 14 oranges. He gave Henry $28\frac{4}{7}$ per cent of them, and then gave Lou 40 per cent of what was left. How many oranges did each child get?

72. NOTE.—"If I have 8 sticks of candy and eat 1 stick, what part of my candy do I eat?" "You eat — of it." "What per cent is that?" "It is $12\frac{1}{2}$ per cent of it, because — of anything is — per cent of it."

73. $12\frac{1}{2}$ per cent, or a profit of $16, was made on a wagon. What did the wagon cost?

74. Said James, "How many marbles have you, Henry?" Henry answered, "I have 63." James thought for a moment, and said, "That is $12\frac{1}{2}$ per cent more than I have." How many had James? (Answer, 56.)

75. Then Henry thought for a moment, and laughing, said, "And what you have is $12\frac{1}{2}$ per cent less than I had yesterday." How many had Henry the day before? (Answer, 64.)

76. A hogshead of molasses contained 56 gallons, but 7 gallons leaked out. What per cent was the leakage?

77. If one-eighth of anything is $12\frac{1}{2}$ per cent of it, what per cent will three-eighths be?

78. Mr. Brown sold a carriage for $88, which was 37½ per cent more than it cost him. What did it cost him?

79. A lady sold a second-hand piano for $95, which was 37½ per cent less than it cost her. What did it cost her?

80. Sold a piece of property so as to gain $150, which was 37½ per cent of its cost. What was its cost? ($400 Ans.)

81. A man invests $160, and by so doing makes a profit of $20. What per cent does he make?

82. A man owed $8,328. Failing in business he paid 16⅔ per cent of his debts. How much did he pay?

83. NOTE—"John has a dime and spends 1 cent for a top. What part of his money does he spend?" "He spends — of his money." "What per cent of it does he spend?" "He spends — per cent of it." "Why?" "Because one-tenth of anything is — of its 100 per cent, which is — per cent."

84. During the war of the Revolution there were five battles fought in New Jersey, which was 10 per cent of the whole number of important battles fought during the war. How many battles were fought?

85. If $99 are 10 per cent more than my money, how much money have I?

86. If $99 are 10 per cent less than my money, how much have I?

87. If I have $99 and add 10 per cent to them, how much have I?

88. If I have $90 and take 10 per cent from them, how much have I left?

89. If $3 are added to $3, what is the per cent of increase?

90. If $3 are added to $4, what is the per cent of increase?

91. If $3 are added to $5, what is the per cent of increase?

92. If I add $3 to $6, what per cent do I increase my money?

NOTE—Three-sevenths, hence 3 times 14⅔ equals 42⅞ per cent.

93. If I add $3 to $7, what per cent do I increase my money?

94. If I add $3 to $8, what per cent do I increase my money?

95. If I add $3 to $9, what per cent do I increase my money?

96. If $3 are added to $10, what per cent is added?

97. A man is in debt $8,328. He fails in business and pays 30

per cent of his debts. What part of them does he pay? How much does he pay?

98. An agent is to buy $800 worth of sugar for me, what must I send him so as to include his commission of 10 per cent?

99. Mr. White bought a farm for $840, and was offered 12½ per cent advance for his bargain. How much was he offered?

100. One cent is what per cent of $1?

101. What is 1 per cent of $640?

102. What is 1 per cent of $860?

103. What is ½ per cent of $860? N. B.—½ of 1 per cent or one-half of $8.60, or $4.30?

104. What is ¼ per cent of $840? One per cent of $840 is —, and ¼ per cent is one-fourth of $8.40, or —.

105. I have $2 and add 50 cents to it. What per cent do I add?

NOTE.—Two dollars contain four 50 cents, then I add one 50 cents to four 50 cents, or I increase my money one-fourth, or 25 per cent.

106. I have $2 and add 25 cents to it. What per cent do I add to it?

107. I have $3 and add 50 cents to it. What per cent do I increase it?

108. One-twelfth of anything is what per cent of it?

109. Buy goods for $24 and sell them for $26. What per cent do I make?

110. B sells goods for $39, and by so doing makes 8⅓ per cent. What was the buying price?

111. C sells a sleigh for $44, which is 8⅓ per cent less than cost. What was the cost?

112. Twelve dollars are 8⅓ per cent of my money. How much have I?

113. Sixty-two dollars are ⅛ of my money. What per cent of my money is that? Why?

114. Eighty-four dollars are ⅛ of my money. What per cent of my money is that? Why?

115. Sixty-eight are ⅛ of the apples I have. What per cent of my apples is that? Why?

116. Ninety-seven dollars are $\frac{1}{4}$ of my money. Then $97 are what per cent of my money?

117. One hundred and eleven dollars are $\frac{9}{7}$ of what I have in my pocket. What per cent is that of all my money?

118. My agent charges me $\frac{1}{2}$ per cent for selling $632 worth of goods. How much do I pay him? One per cent of $632 is $—, and $\frac{1}{2}$ per cent is — of 1 per cent, or —.

119. My agent sold $720 worth of goods for me. He was to have $\frac{1}{4}$ per cent commission and $\frac{1}{4}$ per cent for guaranty. How much did I pay him?

120. I pay my agent $\frac{1}{4}$ per cent for collecting some money for me. How much money do I pay him if he collects $960?

121. I insure my house for $6,500 at the rate of $\frac{3}{4}$ per cent. What does it cost me? One per cent of $6,500 is —, and $\frac{3}{4}$ per cent is — of that, or —.

LESSON VI.

122. What per cent of anything is $\frac{1}{16}$ of it? $\frac{1}{16}$ of anything is — of its — per cent, and $\frac{1}{16}$ of 100 per cent is $6\frac{2}{3}$. $\frac{1}{16}$ of anything, then, is $6\frac{2}{3}$ per cent of it.

123. A clerk gets $15 per week and pays $6\frac{2}{3}$ per cent of it for laundry. How much does his laundry cost him?

124. If Smith & Co. pay $30 for a chandelier and sell it for $32, what per cent do they make?

125. If a lady sold her seal-skin jacket for $80 and gained by doing so $6\frac{2}{3}$ per cent, what did the jacket cost her?

126. A jeweler sold a lady's gold watch for $84 and lost $6\frac{2}{3}$ per cent by doing so. What was the cost of the watch?

127. "What per cent of anything is $\frac{1}{20}$ of it?" "$\frac{1}{20}$ of anything is — per cent of it." "What per cent of anything is $\frac{1}{25}$ of it?" "$\frac{1}{25}$ of anything is — per cent of it." "What per cent of anything is $\frac{1}{30}$ of it?" "$\frac{1}{30}$ of anything is — per cent of it." "What per cent of anything is $\frac{1}{40}$ of it?" "$\frac{1}{40}$ of anything is — per cent of it."

"What per cent of anything is $\frac{1}{100}$ of it?" "$\frac{1}{100}$ of anything is — per cent of it."

128. Sold goods so as to gain \$20, which was 2½ per cent of the cost. What was the cost?

129. Sold goods for \$390 and lost 2½ per cent; then what did they cost me?"

130. Nellie fed her pet squirrel 20 acorns, which was 3½ per cent of all she had. How many had she? Find 2½ per cent of \$6,500.

131. 4 per cent of my money is \$10. How much money have I?

132. 5 per cent of my money equals \$6. How many shoes can I buy with my money at \$3 a pair.

133. John had \$2, and his sister gave him a five-cent piece. What per cent did she increase his money?

134. If we add 25 cents to \$1.75, what per cent do we increase it? Find 2½ per cent of \$7,200.

135. If we add 10 cents to \$2, what per cent do we increase the \$2? Find 2½ per cent of \$520.

136. If to \$4 we add 50 cents, what per cent do we increase it?

137. I add 25 cents to \$3. What per cent do I increase the \$3?

138. George had \$2.50, and then earned 50 cents more. How much per cent did he increase his money?

139. Jennie had \$3 in her bank, and Santa Claus put 50 cents more in her stockings. What per cent of increase was that?

140. If to 25 cents I add 5 cents, what per cent do I add?

141. I have 15 cents, and earn 10 cents more by doing an errand. What per cent do I add to my money?

142. What was the cost of wheat that sold for \$1.30 per bushel, being a profit of 25 per cent? Find 2½ per cent of \$6,400.

143. One-half of a number is what part of its per cent? One-half of a number is one-half of its per cent. $\frac{1}{3}$ of a number is what part of its per cent? $\frac{1}{3}$ of a number is — of its per cent. $\frac{1}{8}$ of a number is what part of its per cent? $\frac{1}{8}$ of a number is — of its per cent. $\frac{7}{11}$ of a number is what part of its per cent? $\frac{7}{11}$ of a number is $\frac{7}{11}$ of its per cent. What is $\frac{1}{11}$ of anything's per cent? $\frac{1}{11}$ of anything's per cent is $\frac{1}{11}$ of 100 per cent, or $\frac{100}{11}$ per cent. Then what is $\frac{7}{11}$? $\frac{7}{11}$ is 7 times

$\frac{100}{11}$ or $\frac{700}{11}$ per cent, or 700 divided by 11, which is $63\frac{7}{11}$ per cent. $\frac{1}{33}$ of anything is equal to what per cent of it? $\frac{1}{33}$ is equal to — of its 100 per cent, or $\frac{100}{33}$ per cent, which equals —.

LESSON VII.

NOTE.—Let each pupil read a question and give its answer. This exercise not only tests the pupils in percentage, but also reviews their work in denominate numbers.

144. One pint is equal to what per cent of a quart?
145. One quart is equal to what per cent of a gallon?
146. One ounce is equal to what per cent of a pound?
147. One quart is equal to what per cent of a bushel?
148. One gill is equal to what per cent of a pint?
149. One gill is equal to what per cent of a quart?
150. One pint is equal to what per cent of a gallon?
151. One pint is equal to what per cent of a peck?
152. One inch is equal to what per cent of a foot?
153. One foot is equal to what per cent of a yard?
154. One and one-half feet are equal to what per cent of a yard?
155. One peck is equal to what per cent of a bushel?
156. In Troy weight, one ounce is equal to what per cent of a pound?
157. One dozen is equal to what per cent of a gross?
158. One quire of paper is equal to what per cent of a ream?
159. One pencil is equal to what per cent of one dozen pencils?
160. One year is equal to what per cent of a score of years?
161. One day is equal to what per cent of a week?
162. One week is equal to what per cent of a fortnight?
163. One month is equal to what per cent of a year?
164. One day of March is equal to what per cent of the whole month?
165. One day of January is equal to what per cent of the whole month?

166. A nickel is equal to what per cent of a dime? Of a quarter?

167. Monday is what per cent of the school days in a week?

168. Forty rods equal what per cent of a mile?

169. One horse is equal to what per cent of a team?

170. One sack of flour is equal to what per cent of a barrel?

171. One day of April equals what per cent of the whole month?

172. One-fifth of an apple is one-half per cent of all my apples. How many apples have I? If one-fifth is one-half per cent, 1 per cent must be — fifths, and 100 per cent is — times — fifths, or — fifths, equal 40 apples.

173. One-third apple is one-third per cent of my apples. How many apples have I?

LESSON VIII.

NOTE.—Have the pupils read this:

174. "When we know what part of anything is taken, how can we find what per cent it is of the thing from which it is taken?" "It is always just such a part of 100 per cent as it is of the thing from which it is taken." "Then if I take $\frac{1}{9}$ of an apple what per cent do I take?" "You take $\frac{1}{9}$ of 100 per cent, or 100 divided by 9, or $\frac{100}{9}$, which is $11\frac{1}{9}$ per cent." "If I have \$21 and spend \$13, what part of my money do I spend?" "You spend $\frac{13}{21}$ of it." "Then what per cent do I spend?" "You spend — of 100 per cent, or $61\frac{9}{21}$ per cent." "How do you find this?" "$\frac{1}{21}$ of 100 per cent is 100 divided by 21, or $\frac{100}{21}$, and $\frac{13}{21}$ is 13 times $\frac{100}{21}$ or $\frac{1300}{21}$ per cent, and this is equal to $61\frac{9}{21}$ per cent."

175. "I have \$13 and spend \$7. What part of my money do I spend?" "You spend — of your money." "What per cent of it do I spend?" "You spend — of 100 per cent." "How much is that?" "$\frac{1}{13}$ of 100 per cent is $\frac{100}{13}$ per cent, and $\frac{7}{13}$ is 7 times $\frac{100}{13}$ or $\frac{700}{13}$ per cent, which is $53\frac{11}{13}$ per cent."

176. "George has \$17 and invests it so as to make \$3. What part of his money does he make?" "He makes — of it." "What per

cent is that?" "It is — of 100 per cent, or (take your pencil and find out) — per cent."

177. "Buy goods for $19 and sell them so as to gain $9. What per cent do I make?" "You make $\frac{900}{19}$ per cent." "Why?" "Because you make $9, which equals $\frac{9}{19}$ of the cost, and hence it must be $\frac{9}{19}$ of 100 per cent. $\frac{1}{19}$ is $\frac{100}{19}$ per cent, and $\frac{9}{19}$ must be 9 times $\frac{100}{19}$ or $\frac{900}{19}$ per cent." "Which is what? Take pencils and find out."

178. Eggs are bought for 17 cents per dozen and are sold for 22 cents per dozen. What per cent is made? When reading, or in oral work, the answer, $\frac{500}{17}$ per cent, may be given, but when working with pencil, the division should be performed and the answer, $29\frac{7}{17}$ per cent, should be given.

179. Buy eggs for 17 cents per dozen and sell them for 25 cents. What per cent is made?

180. Had $31 and earned $7 more. What per cent did I increase my money?

181. There are 63 pounds of sugar in a barrel, and 14 pounds are sold from it. What per cent was sold?

182. An agent charged $8 for selling $97 worth of goods. What per cent did he get?

183. A village had 550 people in 1870 and 567 in 1880. What was the per cent of increase?

184. A city raised $7,850 tax. Eleven per cent of it was paid by Mr. A. How much did A pay?

185. What is 13 per cent of $6,800? One per cent is $68, and 13 per cent is 13 times $68, or —.

186. "A gentleman purchased some coffee for a certain price, and sold it for $824, gaining 3 per cent. What was the cost?" The cost must have been — per cent, and if he gain 3 per cent the selling price must be — per cent. If $824 is 103 per cent, 1 per cent is $\frac{1}{103}$ of $824, or —, and 100 per cent is 100 times —, or —.

187. By selling goods for $327, Mr. Jones makes a profit of 9 per cent. What did he pay for the goods?

188. A farmer has 265 bushels of potatoes, which is 6 per cent more than he had last year. What was last year's yield?

189. There are two elevators near each other. One has 486 bushels of corn in it, which is 8 per cent more than the other has. How many bushels have both?

190. Buy goods in New York and sell them for $754.80, gaining 11 per cent. What did they cost me in New York?

191. By selling sugar for $224 per ton a profit of 12 per cent is made. What did the sugar cost a ton? What a pound?

NOTE.—A single thing always costs as many mills as 1,000 costs dollars. $200 a ton is $100 per thousand. Hence one pound costs 100 mills or 10 cents. Find cost of 17 pounds of hay at $20 per ton. At $40 per ton.

LESSON IX.

192. "A gentleman bought a bill of goods amounting to $40, and received a discount of 10 per cent. What would be the amount of the bill?" "His bill would be $—." "He has thirty days in which to pay the bill; having the cash, however, he asked how much they would give him off for cash. The answer was, '8½ per cent off for cash.' He paid the cash. How much was it?" "It was $33." In speaking of this afterwards, the gentleman said, "I bought a bill of goods amounting to $40, and received a discount of 10 per cent and 8½ off for cash."

193. Smith & Co. bought a bill of goods amounting to $50, on which they received a discount of 20 per cent and 10 off for cash. What was the cash value of the bill?

194. A sewing machine is marked $100. I am told I can have it on thirty days' time for $100, less a discount of 20 per cent and 2½ per cent off for cash. I buy it, and give a check. For what amount do I draw the check?

195. Sold a buggy, for which I asked $64, to Mr. Smith, giving him a discount of 12½ per cent and 14$\frac{2}{7}$ off for cash. How much did I get for my buggy?

196. For how much must I give my check to pay for a bill of goods amounting to $50, on which I get a discount of 4 per cent and 12½ per cent off for cash?

197. I. L. Jones & Co. sell a wagon to G. H. Henry, giving him a discount of 16⅔ per cent and 10 off for cash. What does Mr. Henry pay for the wagon, if the original price of it was $72?

198. What is the cash value of a horse for which $100 is asked, if a discount of 5 per cent is given, and 20 per cent off for cash?

199. Bought a bill of goods for $49, and got a discount of 14⅔ per cent and 16⅔ off for cash. What was the cash value of the bill?

200. Mr. Whitney buys a bill of goods amounting to $72, and is given 60 days time, with a discount of 16⅔ per cent. At the end of 5 days they give him 10 per cent off for cash. How much cash did he pay?

201. What will be the cash value of a bill for $40, on which a discount of 10 per cent and 25 off for cash is given?

LESSON X.

202. "Dell & Co. buy a set of Dickens for $12. They desire to sell them so as to make 33⅓ per cent. For what must they sell them?" "They must sell them for $—." "Yes, they did sell them for $16, but they asked enough more for them so that they discounted 20 per cent from the asking price and still got the $16. What did they ask for them?" "If $16 is what was left after discounting 20 per cent, $16 must be 20 per cent less than the asking price, or one-fifth less. If it is one-fifth less, it can be but four-fifths of it. If $16 are four-fifths, then one-fifth is one-fourth of $16, or $4, and five-fifths must be 5 four dollars, or $20."

203. "To prove this, let us take this problem. I pay $12 for a set of Dickens and mark them $20. From this I discount 20 per cent. What do I get for them, and what per cent do I make?" "Twenty dollars less 20 per cent discount is less one-fifth, and one-fifth of $20 is $4. Twenty dollars less $4 equal $16—what I get. If I pay $12 for books and sell them for $16, I make the difference between $16 and $12, which is $—. Since $—are— of $12, they must be 33⅓ per cent." Name some books written by Dickens.

204. How must goods that cost \$20 be marked, so as to discount 16⅔ per cent and still *make* 25 per cent?

205. If I pay \$16 for a set of Thackeray and desire to sell them so as to make 25 per cent after discounting 20 per cent, what must be the marked price? Name some of Thackeray's books.

206. Rounds & Baily buy a set of George Eliot for \$40. They sell them so as to make 10 per cent after having discounted 20 per cent from the asking price. What was the asking price? Who was George Eliot? What did she write?

207. A book firm bought a set of Scott's works for \$24 and desired to sell them so as to make 12½ per cent after discounting 25 per cent. What did they ask for them? What did they get? Write a list of Scott's books.

208. A Chicago book house paid \$21 for a set of Hawthorne. How must they mark them so as to discount 12½ per cent and still make 33⅓ per cent? Which of Hawthorne's books is thought the best?

209. "A jeweler sold a watch for \$33 and gained 10 per cent by so doing. What per cent would he have gained had he sold it for \$40?" "If, by selling it for \$33 he made 10 per cent, \$33 must be — of the cost, and $\frac{1}{10}$ is \$— and —, or the cost must be \$30. Having found the cost, the next question is not hard to answer, for, if I pay \$30 for a watch and sell it for \$40, I make the difference between \$40 and \$30, or \$10. Since \$10 is — of the cost, it is — per cent."

210. A furniture dealer sold a bedroom set for \$70 and gained 16⅔ per cent by doing so. What per cent would he have gained had he sold it for \$72?

211. What per cent would a wagon-maker gain by selling a wagon for \$56, if by selling it for \$60 he gains 50 per cent?

212. By selling a set of Carlyle for \$26, a profit of 8⅓ per cent is made. What per cent would have been made by selling the set for \$28?

213. Sell a sewing machine for \$63 and gain 5 per cent. What if I had sold it for \$58?

214. A city lot is sold for $660, and 10 per cent profit is gained by doing so. What if the lot had been sold for $570?

215. Sell goods for $82 and gain 2½ per cent. What per cent would I have gained or lost, had I sold for $64?

216. Sell for $56 and make 14¼ per cent. What, had I sold for $53.90, would have been my gain?

LESSON XI.

217. Mr. Jones paid an agent $12 for selling his potatoes, it being ½ per cent. What did the agent get for the potatoes? If $12 is ½ per cent, 1 per cent is —, and if 1 per cent is $—, 100 per cent is 100 times $—, or $2,400.

218. An agent is paid $6 for selling eggs, which is ¼ per cent. What did he get for the eggs?

219. If I pay my agent $8, or ½ per cent, for selling a house and lot, what must he have received for them?

220. $9 were paid an agent, being ¾ per cent, for selling butter. How much did he receive for the butter?

221. $12 equals ⅛ per cent of my money. How much money have I?

222. $14 equals ⅞ per cent of Mr. Smith's money. How much money has he?

223. One-half per cent of Willie's money equals $2.11. How much money has Willie?

224. My agent charges me ¼ per cent for selling goods. His commission is $3.24. What did he sell the goods for, *i. e.*, how many dollars?

225. John Wilmot & Co. pay their agent $5.80 commission, which is ⅝ per cent of what he received for the goods. How much did he receive for them?

LESSON XII.

226. I desire my agent to buy $600 worth of hickory nuts for me. Then I must send him how much? You must send him $600. If I am to pay him 5 per cent for doing the buying, and wish to send his commission with the $600, how much must I send him? You must send him $600 and 5 per cent of $600, or $—, and $600 plus the commission of $— equal $630.

227. Now let us look at this from another side. I send my agent $630, including his commission of 5 per cent, to buy hickory nuts. How much will he spend for the nuts? If the $630 includes his commission of 5 per cent, it contains not only my money, but also the agent's. My money is equal to 100 per cent, and the agent's is 5 per cent; then the $630 must equal 105 per cent, or $\frac{105}{105}$. One-twentieth is — of $630, or $—, and $\frac{100}{105}$, or my share which he is to spend for nuts, must be 20 times $—, or $600.

Teacher's Note.—Sometimes pupils may be made to see this truth by having one of them take two cents (or books) of his own. Then the teacher hands him one cent of his (the teacher's). Then says, "After giving me my money, you may put the rest in your pocket."

What did the words, 'After giving me my money,' imply? That I had two persons' money. Whose? My own and yours.

Then when a problem reads, "An agent received $816 to buy goods, after taking out his commission of 2 per cent," what do we know? "We know that the $816 contain two persons' money,—the agent's 2 per cent and his employer's 100 per cent, or 102 per cent, or $\frac{102}{102}$. $\frac{1}{102}$ will be $\frac{1}{51}$ of $816, and $\frac{100}{102}$ will be 50 times $—, or $800."

228. A man sends his agent $816, including his commission of 2 per cent, to buy apples. How many apples can he buy at $2 per barrel?

229. A merchant sends his agent $4,623, which includes the agent's commission of one-half per cent, to buy flour at $5 per barrel. How many barrels can he buy?

230. NOTE.—One-half per cent of anything is equal to what part of it? 1 per cent of $2 is $.02. Then one-half per cent of $2 is $.01. 1 cent is what part of $2? There are 200 cents in two dollars, hence

one cent is — of $2. 1 cent is also one-half per cent of $2. Hence one-half per cent of anything is — of it.

Then in example 229 : $4,623 must contain $\frac{1}{200}$ (the agent's share) plus $\frac{199}{200}$ (the merchant's share), or — and $\frac{1}{200}$ is — of $4,623, or $23, and $\frac{199}{200}$ is — times $23 or $—. At $5 a barrel, $4,600 will buy 920 barrels of flour.

231. I send my agent in Chicago $1,005, which includes his commission of one-half per cent. How many pounds of tea at $1 per pound can he buy for me?

232. White, Jones & Co., of New York, send their agent in Boston $2,653.20 to buy guns at $2 each. How many can he buy after taking out his commission of one-half per cent?

233. I send to my agent in New York, including his commission of $2\frac{1}{2}$ per cent, $861, with which to buy goods. How much sugar at $10 per barrel can he buy?

234. Johnson & Co. send their agent $4,879.21, which includes his commission of one-third per cent, to buy rice at 4 cents per pound. How many pounds did he buy?

235. If an agent receives $2,486.20, including his commission of one-fourth per cent, how much of the money is his employer's? How much was his?

236. I pay $48 for a buggy, after having received a discount of $12\frac{1}{2}$ per cent and $14\frac{2}{7}$ per cent off for cash. What was the *list price* of the buggy?

237. What must have been the *list* price of a sewing machine costing me $76, after I had been given a discount of 5 per cent and 20 off for cash?

238. Mr. Smith paid $27 for a bill of goods after getting a discount of 10 per cent and 25 off for cash. What was the original amount of the bill?

NOTE.—One per cent of $3 equals 3 cents, then one-third per cent equals 1 cent. One cent is $\frac{1}{300}$ of $3. Hence one-third per cent of anything is — of it. Then $4,879.21 must equal $\frac{299}{300}$ of the amount to be spent for rice.

LESSON XIII.

239. It often happens that men associate themselves together into a company for the purpose of doing business. There may be a rich gold mine somewhere that will cost to get opened, etc., $2,000,000. No one man desires to risk so much, so a stock company is formed. The company has a president, secretary and board of directors. Each member is given a certificate showing how many shares of stock he owns. The price for which these shares are issued per share is called the *par value*, and as a rule they cost $100. If the gold mine is a good one and the yield is large, the stock will soon be worth more than $100, as people will want to purchase it. It is then said to be *above par*. If it does not yield much, the shareholders will want to sell their stock, and will be willing to take less than $100, the cost. It is then said to be *below par*. The premiums, discounts, dividends (net earnings) and stock commissions are usually estimated upon the *par* value of the stock. Then if a broker buys stock for me at, say 2 per cent commission, he will get 2 per cent of $100, or $2 for each share he buys.

240. What will 20 shares of mining stock cost me at $102 per share (or we might say at 102) brokerage being 2 per cent? Brokerage being 2 per cent, each share will cost me $102, the *market* value of the stock, plus $2, the brokerage, or $104, and 20 shares will cost me twenty $104, or $2,080.

241. What will 20 shares of R. R. stock cost at 98, brokerage being 1 per cent? Since the brokerage is 1 per cent, each share will cost me $98 plus $—, the brokerage, or $—, and 20 shares will cost 20 times $99, or $1,980.

242. What will be gained on 50 shares of R. R. stock bought at 97 and sold at 102, the brokerage being 2 per cent each way, *i. e.*, 2 per cent for buying and 2 per cent for selling. When bought each share cost me, with the brokerage $—. When sold I receive but $— for each share, after the brokerage was taken out. Then on 50 shares I gain $50.

243. My broker, whom I pay 1 per cent each way, buys 15 shares of O. L. C. R. R. stock for me at 96, and afterward sells it for 103. How much do I gain by the transaction?

244. Buy stock for 93 and sell for 98, what do I gain on 12 shares, if I pay 1 per cent for buying and 2 per cent for selling?

245. I pay my broker one-half per cent each way for buying and selling 250 shares of stock for me. What is my profit, if he bought for 87 and sold for 99?

246. I send my broker $1,932 to buy stock at 91. How many shares can he buy, the brokerage being 1 per cent?

Since the brokerage is 1 per cent, each share will cost $91 plus $1, or $92; and $1,932 will buy as many shares as there are 92 dollars in 1932 dollars, or $21.

247. How many shares, brokerage being 2½ per cent, can be bought with $3,820 at 93 per share?

248. If brokerage is 1½ per cent, how many shares of mining stock can be bought with $6,210, if the market value of a share is $102?

LESSON XIV.

249. I buy a sewing machine for $80, and receive a discount of 5 per cent, and 2½ off for cash. What do I pay for the machine?

250. How must I mark goods costing $30, so as to make 30 per cent, after having discounted 2½ per cent?

251. By selling goods for $88, I made 10 per cent. Would I have made or lost by selling for $78, and what per cent?

252. I send my agent, including his commission of 2½ per cent, $902, to buy apples at $5 per barrel. How many barrels did he buy?

253. I pay $9 for a gun, after having received a discount of 16⅔ per cent and 10 off for cash. What was the list price of the gun?

254. In 1880 a village had 728 people. In 1890 there were 842. What was the per cent of increase?

255. A collecting agent received $7.05 commission, which was ½ per cent on amount collected. How much did he collect?

256. John gave William ⅛ of an apple, which was ½ per cent of all the apples John had. How many apples had John?

257. Mr. Johnson sold a city lot for $810, and gained 12½ per cent by doing so. What did the lot cost him?

258. Mr. Williams sold a city lot for $490, and lost 12½ per cent by doing so. What did Mr. Williams' lot cost him?

259. One-half of ¼ per cent of my money equals $2. How much money have I? ($1,600 Ans.)

260. John had $1 and earned $1. What per cent did he increase his money? He then earned 25 cents. What per cent did he increase his second amount?

261. One-half of ¼ per cent of my money equals 6 cents. How much money have I?

262. One dollar is ½ of ¼ per cent of John's money. How much money has he?

263. One-third of ⅛ per cent of Will's apples equal 2 apples. How many apples has Will?

264. Two-thirds of ½ per cent of my apples are 4 apples. How many apples have I?

LESSON XV.

NOTE.—Let the children read this:

As you all know, your father has to pay to the city and state each year some money which he calls his taxes. It is right that every man help to raise the money which is used to pay for lighting and cleaning our streets, building our roads, our schools, our prisons (though many people think if more were paid for the right kind of schools less would have to be paid for the prisons), our court house, the care of those who have been unfortunate in life, and for many other necessary public expenses.

As Dr. Payne says in his excellent talk on this subject, "There would be much less grumbling at the tax-gatherer if men could clearly conceive the condition of societies where no taxes are levied."

In this country men seldom do object to paying their taxes, but they do object, as they have a right, to any extravagant expenditures of this money.

Only honest men should be given the privilege of using such funds, and only honest men will be given any such privilege if the voters do their duty. Remember this when you cast your first vote, and never thereafter forget it.

NOTE.—Draw a plan of a little city on the B. B. Let the children independently tell which lots are the most valuable, and why they think so; they will nearly all agree. How could they tell? Then how can the Assessor tell? What kind of men should be elected Assessors?

1. If the property was valued at $25, and $5 tax were to be raised, what would be the per cent, or rate of tax, as it is called?

That is, what part of $25 will give $5? We know it is one-fifth, hence the rate would be 20 per cent.

2. If the property was valued at $250, and the taxes were to be $5? $\frac{1}{50}$ of 100 per cent, or $\frac{100}{250}$ per cent, or — per cent.

3. If the property was valued at $2,500, and the taxes were to be $5?

4. What would be B's tax, whose property is worth $800?

NOTE.—Since the rate is $\frac{1}{5}$ per cent, B would pay $\frac{1}{5}$ per cent of $800. One per cent is $8, and $\frac{1}{5}$ per cent is one-fifth of 1 per cent, or $1.60.

5. The property is valued at $8,600, and the amount of tax is $43. What is the rate?

6. The property is valued at $986,600, and the amount to be raised by tax is $4,933. What will be A's tax on property valued at $6,500?

7. There is to be raised in a city $108,640 tax. Of this, $10,000 are paid as personal tax, that is, on other than real estate property. Then how much is to be raised on the real estate property?

8. What will be the rate of the tax on the $98,640 to be raised on the real estate property which the Assessor valued at $9,864,000?

9. And what will be C's tax, who has a lot valued at $1,400, and who pays a poll tax (or personal tax) of $4?

PART II.

FIRST LESSONS IN INTEREST.

1. A has money to lend. He charges 6 cents for the use of $1 for 1 year. If B borrows $1 for 1 year, then how much must he pay for the use of the money?

2. How much must C pay for $2? How much must D pay for $3? How much must E pay for $4? How much must F pay for $5?

3. G borrows $1 but keeps it for only 2 months; what part of a year does he keep it? Then what part of 6 cents must he pay for the use of the $1? What must H pay for the use of $2 for 2 months? What must I pay for the use of $3 for 2 months? What must J pay for the use of $4 for 2 months? What must K pay for the use of $8 for 2 months?

4. What do you discover as to the number of cents paid each time when the money is lent for 2 months or $\frac{1}{6}$ of a year?

(There are just as many cents paid for the use of the money as there are dollars lent.)

5. L borrows $2 for 2 months. What does he pay for the use of it? What should M pay for $2 for 1 month? What should N pay for $4 for 1 month? What should O pay for $6 for 1 month? What should P pay for $8 for 1 month?

6. Q has the use of $8 for 1 year. How much must he pay for the use of it?

7. R has the use of $8 for 2 months. What must he pay for the use of it?

8. S has the use of $8 for 1 month. What must he pay for the use of it?

9. T has the use of 8 for $3 months. What must he pay for the use of it? For 4 months? For 6 months? For 5 months? For 8 months?

10. What will U pay for $12 for 3 months? What will V pay for $18 for 2 months? What will W pay for $18 for 1 month? What will X pay for $18 for 7 months?

11. Y borrows $30 for 15 days, what must he pay for the use of it? What for 10 days? For 20 days? For 6 days?

The following problems should be worked without the pencil and slate or paper. Go over them the second time, calling the time 8 months, then 7, etc. Thus a review of the "multiplication table" is given each time.

12. Z borrows $18 for 10 months. What must he pay for the use of it?

13. What for $20 for 10 months?

14. What for $10 for 10 months?

15. What for $16 for 10 months?

16. What for $12 for 10 months?

17. What for $8 for 10 months?

18. What for $24 for 10 months?

19. What for $22 for 10 months?

20. What for $6 for 10 months?

21. What for $14 for 10 months?

22. What for $4 for 10 months?

23. What do we call money paid for the use of a house? What do we call money paid for clerking? What do we call money paid to have our house insured? What do we call money paid for the use of money?

LESSON II.

Find the interest on $420 for 6 days. (42 cents Ans.)

24. Find the interest on $660 for 2 years 6 months. (N. B. 30 months.)

How much interest must be paid for the use of $840 for 1 year, 2 months and 15 days? (N. B. 14½ months.)

$8.40 equals 2 months.

$4.20 equals 1 month. (14.5 times $4.20 equals $60.90.)

$60.90 equals 14.5 months.

25. What would be the interest on $840 for 1 year, 2 months and 15 days if the interest was 7 cents a year for one dollar, or 7 per cent instead of 6 per cent? We have found, in problem 24, that at 6 per cent the interest is $60.90. At 1 per cent it must be $\frac{1}{6}$ of $60.90, or $10.15. If $60.90 is the interest at 6 per cent and $10.15 is the interest at 1 per cent, the *sum* of $60.90 and $10.15, or $71.05, must be the interest at 7 per cent. Or we might say if $10.15 is the interest at 1 per cent, then 7 times $10.15 equals $71.05 is the interest at 7 per cent.

26. Find the interest on $420 for 1 year, 3 months, 9 days, at 7 per cent. Next at 5 per cent.

$4.20 equals 2 months at 6 per cent.

$2.10 equals 1 month at 6 per cent.

$32.13 equals 1 year, 3 months, 9 days, or 15.3 months, at 6 per cent.

One-sixth of $32.13, or $5.355 equals interest at 1 per cent.

The sum of $32.13 and $5.36, or $37.49, equals the interest at 7 per cent.

$32.13 less $5.36, or $26.77, equals the interest at 5 per cent.

27. Find the interest on $840 for 10 months at 6 per cent. At 7 per cent.

28. What is the interest on $640 for 1 year, 8 months, 3 days, at 6 per cent?

29. What is the interest on $48 for one month at 5 per cent?

30. $240. CHICAGO, ILL., Feb. 27, 1893.

Six months after date I promise to pay A B, or order, two hundred and fifty dollars, value received, with interest at 6 per cent.

J. W.

What was the interest on this note? What kind of a note is it? Make it a demand note. Make it payable at a bank.

LESSON III.

Find the interest on the following at 6 per cent, then at 7 per cent, next at 9 per cent:

1. $848 for 2 years, 3 months, 9 days.

2. $642 for 1 year, 2 months, 6 days.
3. $900 for 2 years, 3 months, 15 days.
4. $250 for 9 months, 21 days.
5. $780 for 4 years, 7 months, 18 days.
6. $28 for 2 years, 2 months, 3 days.
7. $128 for 1 year, 1 month, 5 days.

TO FIND THE PRINCIPAL.

1. The interest on a note was $42, the rate 6 per cent and the time 10 months. What was the face of the note?

NOTE.—If the interest for 10 months was $42, or 4,200 cents, the interest for 1 month was $\frac{1}{10}$ of 4,200 cents, or 420 cents, and for 2 months it was 2 x 420 cents, or 840 cents, hence the face of the note was $840.

2. The time was 5 months, the interest $16, the rate 6 per cent. What was the principal or face of the note?

3. The rate was 6 per cent, the time 7 months and the interest $13.30. What was the principal?

4. I receive from A $3.44 interest. He had my money 8 months at 6 per cent. How much did I lend him?

5. C paid B $3.15 interest, having had the money for 1 year 3 months at 6 per cent. How much did B lend C?

TO FIND THE TIME.

I receive $38.70 interest at 6 per cent on $860. How long did the note run?

NOTE.—The interest on $860 for one month was $4.30. It took $860 as many months to earn $38.70 as there are $4.30 in $38.70, *i.e.*, $38.70 divided by $4.30 equal 9 ($4.30) hence 9 months.

2. Mr. Roe paid Mr. Doe $2.09 interest at 6 per cent. How long did Mr. Roe have the $38 which he borrowed?

3. If the interest was $14.40, the principal $720 and the rate 6 per cent, what was the time?

4. The principal was $540, the rate 6 per cent and the interest $81. What was the time?

5. How long did a note run that was given for $60 at 6 per cent, the interest having been 6 cents?

6. Interest $14.70, rate 7 per cent, principal $840. What was the time?

PARTIAL PAYMENTS.

NOTE.—The author has used different methods in teaching partial payments. The one which he gives here is his favorite. When the class can find the interest on any principal, at any rate, for any time, and can also work the problems, in interest; *i. e.*, find the time, or rate, or principal, they are ready to take up partial payments. He begins by dictating to them a note, which they write on paper with ink, as follows:

$800. NEWARK, N. J., January 1st, 1880.

On demand I promise to pay to J. W. or order, eight hundred dollars, value received, with interest. A. B.

On July 1st, 1880, and at other times, A. B. pays J. W. *part* of this note, or $124. A. B. desires a record made of these that he may show in the future that he paid them. J. W. makes a record of them on the back of the note, where they will be safe; for if he loses the record he also loses the note. (*See Business Forms.*) Turn over your note and write, near the top, crosswise, the following:

Received on the within note,

July 1st, 1880, - - - -	$124.
November 1st, 1880, - - -	114.
July 1st, 1881, - - - -	224.
November 1st, 1881, - - -	208.

On December 1st, 1881, A. B. desires to settle; how much does he owe J. W.?

Find the time as shown below.

"How much did A. B. owe?" "$800." "How long before he made a *partial* payment of the note?" "Six months." "What is the interest for that time?" "$24." "How much did A. B. then owe?" "$824." "How much did he pay?" "$124." "What does he still owe?" "$700." "Then on what shall he now pay interest?" "On $700?" "How long before he made the next par-

tial payment?" "Four months." "What is the interest for that time?" "$14," etc. Notice that there is no reserve payment and that the work all comes out nicely, in order that the *mechanical* part of this new work may not interfere with the perfect understanding of the subject.

As the questions are asked the teacher works on the blackboard and the pupils on their slates.

1880	7	1	$124	$800 Principal.
1880	1	1		24 First Interest.
	6			$824 " Amount.
				124 " Payment.
1880	11	1	$114	$700 Second Principal.
1880	7	1		14 " Interest.
	4			$714 " Amount.
				114 " Payment.
1881	7	1	$224	$600 Third Principal.
1880	11	1		24 " Interest.
	8			$624 " Amount.
				224 " Payment.
1881	11	1	$208	$400 Fourth Principal.
1881	7	1		8 " Interest.
	4			$408 " Amount.
				208 " Payment.
1881	12	1		$200 Fifth Principal.
1881	11	1		1 " Interest.
	1			$201 Amount due at settlement.

NOTE.—Next let the pupils try one independently and to save work, the teacher may give the same example with this difference; make the principal and each payment just one-half as large, using the same time; thus: $400 principal. Endorsements $62; $57; $112; $104; and, of course, the answer will be one-half as great, or $100.50.

Again, to make the work still more independent the teacher may give the class another test, giving to those pupils who sit on the left side of the seat, a principal just double the first, with each payment two times as large, or \$1600 principal and endorsements \$248; \$228; \$448; \$416; at the same time giving to those pupils sitting on the right side of the seats a principal and payments ten times as large, or \$8000 principal; endorsements \$1240; \$1140; \$2240; \$2080. The answers are \$402 and \$2010.

I think it wise to keep the pupils working such examples two or three periods, when they will be in good condition to take the next step which will be an example in which *one* reserve is made. Let this example also be a *live* one, *i. e.* fresh from the teacher's own mind. Do not make it as long as the first and let the work come out nicely each time, thus:

1860	6	1	\$106	\$600	1st Prin.
1860	4	1		6 "	Int.
	2	0		\$606 "	Amt.
1860	10	1	\$8	106 "	Payt.
1860	6	1		\$500	2d Prin.
	4		\$10, 1st Res.*		
1861	10	1	\$132	1st Reserve Payment	\$ 8
1860	10	1		2d " "	132
1			30, 2d Res.	Sum	\$140
			\$40 Sum.	\$40	
				540	
1862	10	1		140	
1861	10	1		\$400	3d Prin.
1				24	3d Int.

Amount due when settled, \$424

Test as before, first taking one-half of each and letting all work, then two times as large for one side and ten times as large for the other side.

*Lead them to see that if we add the \$10 we obtain \$510. Now if we take from this the payment, \$8, we get \$502, which is more to draw interest, by \$2, than there would have been had there been no payment made. This is not fair to the debtor; hence, we reserve the interest and payment until the payment is more than the interest. This good law has been adopted by the Supreme Court of the United States, and is in use by nearly all the States in the Union.

If, after many examples like the above have been worked, the pupils be given a problem in which there are many reserves, they will obtain a better understanding of what is meant by reserved payments, and may next be given any problem that is found in our text books.

$600. NEW YORK, January 1st, 1870.

On demand, I promise to pay J. W., or order, six hundred dollars, value received, with interest at 6 per cent. A. B.

This note was endorsed as follows:

January 1st, 1871, - - - -	$136.
July 1st, 1871, - - - -	14.
November 1st, 1871, - - -	10.
July 1st, 1872, - - - -	15.
May 1st, 1873, - - - -	226.

What was due May 1st, 1874?

$323.30, answer.

When problems like the last are worked by the pupils, they are ready to be taught the rule for partial payments and the definition of endorsement, note, partial payment, etc., if the teacher thinks it best to teach them.

1. $750.00. WASHINGTON, D. C., Jan. 7, 1870.

Four months after date, I promise to pay A. B., or order, seven hundred and fifty dollars, with interest at 6 per cent. Value received. H. B.

Endorsed: June 10, 1870, $43; February 17, 1871, $15.45; November 23, 1871, $78.60. What was due August 25, 1872?

2. Note given May 20, 1874, for $16,500; endorsed: September 8, 1874, $450; December 14, 1874, $300; February 26, 1875, $500; July 5, 1875, $300; November 14, 1875, $2,500. What was due May 2, 1876?

3. Note $12,000; given June 20, 1874; endorsed October 2, 1874, $2,204; February 29, 1876, $480; May 23, 1876, $2,505; December 11, 1876, $2,264. What was due January 21, 1877?

4. A note given January 1, 1841, for $8,500 at 6 per cent, was

endorsed as follows: July 1, 1841, $1,006.20; December 1, 1841, $152.80; August 13, 1842, $1,757.50. What was due January 1, 1843?

5. $350.00 CHICAGO, ILL., May 7, 1868.

One day from date I promise to pay J. J., or order, three hundred and fifty dollars, with interest at 7 per cent, value received.

A. A.

Endorsed as follows: September 17, 1870, $100; February 10, 1872, $50. What was due October 25, 1872?

REVIEWS IN INTEREST.

1. The interest is $225; the rate 6 per cent; the time 2 years and 6 months. What is the principal?
2. How long will it take $500 to gain $45 at 6 per cent?
3. Find the bank discount on $368 for 3 months; that is, add 3 days to the time and get the interest.
4. Find the interest on $600 for 1 year at 10 per cent.
5. A note on demand without interest was given July 1, 1870, for $640. Demand was made November 1, 1870. Note paid March 1, 1871. What was due?

NOTE.—Reckon interest from time demand was made.

Rate always 6 per cent when not given in the problem.

REVIEWS.

LESSON I.

6. I have a house for which I ask a cash price of $740. What will I gain by taking a note for $890, due in 2 years and 6 months, without interest, money being worth 8 per cent?
7. I take B's note for $542 at 8 per cent. How much will he owe me at the end of 4 years, 9 months and 18 days?
8. Find the difference between the bank discount and interest on $420 for 4 months.

9. B agrees to pay A $45.50 for the use of $260 for 2½ years. What rate does A get on his money?

NOTE.—First find what the interest would be at 1 per cent; $45.50 divided by interest at 1 per cent equals rate.

10. Mr. Williams let Mr. Henry have $350 at 6 per cent interest. H. paid W. $63 for the use of it. How long did H. keep the money?

11. For how long did I lend A $111 if he paid me $2.22 interest at 8 per cent?

12. At what rate did I lend B $811 if he paid me $48.66 interest for 1 year and 6 months?

13. What principal will gain $54 interest in 1 year and 6 months at 4 per cent?

14. What principal will amount to $104.50 in 6 months at 9 per cent.

15. A paid B $31.60 interest on a note for $320 at 6 per cent. How long had A the money?

16. The interest on a bond for $320 amounted to $15.08 in 1 year, 1 month and 6 days. What was the rate of interest?

17. How much is the bank discount on $350 for 3 months at 6 per cent?

18. I desire to pay a debt of $500. For what sum must I draw a note to realize it, discounting it at 90 days?

19. A note given July 1, 1865, for $548 was paid March 13, 1866; what was due at that time; rate 5 per cent?

20. A pays $105 for the use of some money at 6 per cent for 2 years and 4 months; how much money does he borrow?

21. I lend a man some money. At the end of 2 years and 4 months he pays me $855, which includes the interest; how much did I lend him?

22. Find the interest on $150 for 1 month and 6 days at 7 per cent.

REVIEWS IN INTEREST.

23. Interest, $84.90; principal, $600.00. What is the time?

24. The time is 8 months and 12 days. The interest is $6.776. Principal, $88. What is the rate?

25. A note amounted to $304.25 in 3 years, 1 month and 6 days at 7 per cent. What was the principal?

26. At what rate must I lend $236 if I desire to receive $17.70 interest in 1 year and 3 months?

27. I desire the proceeds to be $640. Time 4 months. What must be the face of the note so that after being discounted at a bank I can obtain that amount?

28. A note for $840, payable 4 months after date (January 1, 1865), without interest, was paid May 18, 1865. What was the interest?

LESSON II.

29. What is the sum of the simple interest and bank discount of $20,000 for 6 months?

30. For how long did I lend A $111 if he paid me $2.22 interest at 8 per cent?

31. At what rate did I lend B $811 if he paid me $48.66 interest for 1 year and 6 months?

32. What principal will earn $54 interest in 1 year and 6 months at 4 per cent?

33. What principal will amount to $104.50 in 6 months at 9 per cent?

34. A note was given January 1, 1880, for $320, payable 3 months after date without interest. It was paid June 19, 1880; how much interest was due on it?

35. I have a house for which I ask a cash price of $740. What will I gain by taking a note for $890, due in 2 years and 6 months without interest, money being worth 8 per cent?

36. I take B's note for $542 at 8 per cent. How much will he owe me at the end of 4 years, 9 months and 17 days?

37. 120\frac{00}{100}$. NEWARK, N. J., October 29, 1889.

Six months after date I promise to pay A. Buywell, or order, one hundred and twenty and $\frac{00}{100}$ dollars, for value received, with interest. JOHN X. GOODPAY.

This is a good opportunity to impress them with the foolishness of signing their names to promiscuous papers. One of these notes so signed might be held against them. Never sign other men's names without permission, etc.

N. B.—Write again and omit the words "or order," thus making a non-negotiable note. What is the meaning of non-negotiable? What was due on the above time note when paid?

$400\frac{50}{100}$. CHICAGO, ILL., May 10, 1889.

On demand I promise to pay Henry Collect or order, four hundred and $\frac{50}{100}$ dollars, for value received, with interest at 4 per cent. WILLIAM GOODPAY.

What was due on the above *demand* note when paid, viz.: Oct. 10, 1889?

BUSINESS FORMS.

LESSON I.

$\$400\frac{00}{100}$. NEWARK, N. J., May 22, 1887.

Three months after date, I promise to pay A. B. Smiles, or order, four hundred dollars, value received, with interest.

HENRY S. PAYWELL.

NOTE.—Let each pupil have a piece of paper. All copy the note here given. Next have them turn the note over and add the endorsements as given below:

Received on the within note payments as follows:

Aug. 2, 1887, $\$98\frac{00}{100}$
Oct. 25, 1887, $37\frac{50}{100}$
Feb. 14, 1888, $80\frac{75}{100}$

Received payment in full, March 10, 1888.
A. B. SMILES.

As a rule, checks are printed with a blank space to be filled in. Should one desire to write a check in full, he may do so thus:

CHICAGO, ILL., May 22, 1893.

THE CHICAGO CITY NATIONAL BANK.

Pay to the order of H. S. Goodfellow, five and $\frac{75}{100}$ dollars.

$\$5\frac{75}{100}$ WILLIAM BALANCE.

If Mr. Goodfellow should send William Jackson to the bank to draw this money, he would turn the check and write on it as shown below. Notice that Mr. Jackson also signs it.

Pay to the order of

WILLIAM JACKSON.

H. S. GOODFELLOW.

WILLIAM JACKSON.

Julia W. Smith paid Mrs. Helen K. White thirty-five dollars for one month's board and asked Mrs. White for a receipt. Notice how it is written.

I.

$\$35\frac{00}{100}$ NEW HAVEN, May 1, 1889.

Received from Julia W. Smith, thirty-five $\frac{00}{100}$ dollars for board to date.

HELEN K. WHITE.

II.

$22\frac{50}{100}$ NEWARK, N. J., July 1, 1889.

Received from Wm. H. Milford, twenty-two $\frac{50}{100}$ dollars, in payment for house rent for the month of June, 1889.

THOMAS GOODFELLOW.

III.

$25\frac{00}{100}$ NEWARK, N. J., Aug. 1, 1889.

Received from Cleon M. Smithers, twenty-five $\frac{00}{100}$ dollars, to balance account.

MALCOLM MCCLURE.

LESSON II.

A RECEIPTED BILL.

CHICAGO, ILL., Oct. 17, 1893.

JOHN H. BILLINGS,

To WILLIAM SMITH, DR.

		To ½ ton Nut Coal, - @ $5	2	50			
		" 2 " Stove " - " $6	12	00			
					14	50	
		Received payment,					
		WILLIAM SMITH.					

Some people prefer this form :

CHICAGO, ILL., Oct. 17, 1893.

JOHN H. BILLINGS,

BOUGHT OF WILLIAM SMITH,

		½ ton Nut Coal, - - @ $5	2	50			
		2 " Stove " - - " $6	12	00			
					14	50	
		Received payment,					
		WILLIAM SMITH.					

LESSON III.

HOW TO KEEP A CASH BOOK.

Take some strips of paper about the size of a dollar bill, and fill them out as follows:

Oct. 1, 1886.

BUY A BOOK.

Cost, $3.

Oct. 2, 1886.

COLLECT RENT.

$9.

Oct. 3, 1886.

PAY ON ACCOUNT.

$8.

Next make some school money, as follows:

SCHOOL BANK,

GOOD FOR FIVE SCHOOL DOLLARS.

J. GOODPAY,

$5. *Cashier.*

NOTE.—Have enough of the first slips to give each child one. Then in some part of the room have a box containing from one to two hundred dollars of the school money in one, two, five, ten and twenty dollar bills.

Now I shall try to make it plain to you when and why cash is Dr. and Cr. I lend John Stevens, or any other pupil, $30 and ask you who owes me the $30. You tell me John Stevens. "Why?" "Because you lent it to him." "Very well. Here I have a cash-box or drawer, or safe, which I shall call cash for short, and I put $30 into that. Now who owes me?" "Cash" you say. "Why?" "Because you lent it to Cash," you say again. "Then Cash is what to me?" "Is debtor to you." "Yes, or Dr. to me we may say." "What if I put $10 more in the drawer?" "Cash is Dr. to $10 more," you tell me. "Right."

"If George Kirk does me a good turn, to whom shall I give credit?" You answer "To George Kirk." "Yes, and if Cash does me a good turn, to whom shall I give credit?" Again you answer "To Cash." "Well, George pays my rent for me. Is that a good turn?" "Yes." "Then I should give George what?" "Give him Cr. for doing the good turn," you see at once. "What if Cash pays my rent; is that a good turn?" "Yes, sir." "Then I must give Cash Cr. for doing what?" "Paying your rent," you are ready to tell me. "Very well, then, if I take out any cash, to pay any bills, I must do what?" "Give Cash credit for it," you know at once.

"We are now ready to begin. I count my money and find I have $30 which I now put in the drawer. You may each make the entry in your book." You each write, "Oct. 1, 1886. To amt. on hand $30," and place the $30 in the Dr. column. See below.

I now call on the pupil whose slip is dated Oct. 1 to come to my desk, when Bertha comes and says, "I am to buy a book for $3," at the same time paying for it from the pile of money mentioned above. I shall encourage you to cause me to make change,—*i. e.*, Bertha pays me with a $5 bill and I give her $2 change. After this you make the entry. All write, "To rec'd for book $3." See below again. When Oct. 2, 1886, is called, Minnie may come to my desk and say: "I am to collect rent, $9," because her slip reads "Collect rent, $9."

I shall give her a $20 bill. She will give me the change, and the class will write, "By paid Minnie rent $9," which is placed in the Cr. column, thus: By paid Minnie rent $9, because this is a favor from Cash to me.

Then Will collects insurance, $3.
Henry will pay on account, $8.
Jennie will pay for a dress, $20.
John will collect his salary, $6.
Mary will pay the balance of her account, $5.
James will buy a hat, $10.
Frank will collect expressage, $2.

And when you have all brought up your slips those who have made no mistakes can tell me just how much money I have on hand. If there were just ten entries as here shown, I should be told by you that I have $56. I count my money and find you are right. I then *balance* my cash book by entering this $56 in red ink on the Cr. side. I put it in red ink to show that cash is not really Cr. by $56, but it is written there simply to balance the book. When this last entry is written our "Cash Book" should look as shown below.

	Cash.	*Dr.*		*Cr.*	
1886					
Oct. 1	To am't on hand,	$30	00		
" 2	" rec'd for book,	3	00		
" "	By paid Minnie's rent,			9	00
" 3	" " Insurance, F. I. Co.,			3	00
" "	To rec'd of Henry on acc't,	8	00		
" 4	" " for dress,	20	00		
" "	By paid clerk, J. White,			6	00
" 5	To rec'd of Mary to bal. acc't,	5	00		
" 6	" " for hat,	10	00		
" "	By paid express, A. Ex. Co.,			2	00
" 8	" balance (*am't on hand*),			56	00
		76	00	76	00

LESSON IV.

Business letters should be short. Notice how to sign a letter for another (see below). Also where to place the stamp on the envelope.

NEWARK, N. J., March 1, 1889.

A. Lovell & Co.,

GENTLEMEN: Be kind enough to inform me what your introduction price is for "Selected Words for Spelling," etc. Also, on what terms you will exchange for old spellers.

Yours truly, WILLIAM MILFORD.

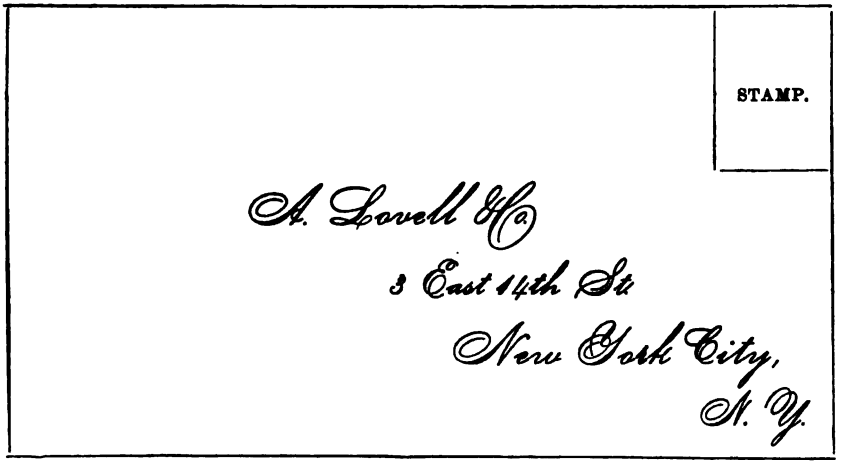
NEW YORK CITY, N. Y., March 2, 1889.

William Milford, Esq.,

DEAR SIR: In answer to yours of the 1st inst., will say that our introduction price for "Selected Words," etc., is 18 cents, and that we will exchange for old spellers for 10 cents. Trusting you will favor us with an order, we remain

Yours truly,

A. LOVELL & Co.,
Per W. M. G.



When writing letter enclosing check or money order for books, etc., take special pains to write your name and address with care.

Remember strangers do not know how to spell your name. Again, if a lady, either write your Christian name in full or add Miss before your initials, thus: (Miss) J. A. Smith. Otherwise the publisher will send the package, no doubt, to J. A. Smith, Esq.

814 BROOK ST., NEWARK, N. J., October 17, 1893.

A. Flanagan,

DEAR SIR: Enclosed find a money order for three dollars ($3), for which please send to my address fifteen copies of Miss Cook's "Nature Myths and Stories for Children."

Yours truly,

MARY E. WHITMORE.

Sometimes instead of paying cash to a man who has worked for us, we give him an order on our grocerman, if he is willing to take it. An order may be written in different ways. Try to make it plain, short, and to the point, to avoid misunderstandings.

1. *Plumb & Co.,* May 22, 1889.

GENTLEMEN: Let the bearer have the following articles and charge the same to my acct.

1 sack best flour,	$1.25
7 lbs. best brown sugar,	.70
3 large flower pots,	.45
1 lb. Rio coffee,	.30
1 lb. Japan tea,	.40
Total,	$3.10

JOHN K. RICE.

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2. *Plumb & Co.,* May 22, 1889.

GENTLEMEN: Let the bearer have goods to the amount of three and $\frac{10}{100}$ dollars ($3.10), and charge the same to my acc't.

JOHN K. RICE.

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3. *Plumb & Co.,* May 22, 1889.

GENTLEMEN: Let John White, or bearer, have three dollars' ($3) worth of goods and charge the same to me.

JOHN K. RICE.

LESSON V.

WANTS.

WANTED.—A bright boy or girl as an assistant book-keeper. References required. Address White, Brown & Co., No. 800 Blank Street, New York City.

Notice how H. W. Goodworth answered this advertisement.

NEWARK, N. J., June 3, 1889.

White, Brown & Co.,

GENTLEMEN: My attention has been called to your advertisement for an assistant book-keeper. I beg leave to offer myself as an applicant for the position.

I am sixteen years of age, a graduate of Blank School, under the superintendence of Mr. John Bright, to whom I refer. Hoping to hear from you in the near future, I am

Yours truly,

WHITE, BROWN & Co., H. W. GOODWORTH.
New York City.

How to write advertisements for the daily papers:

1. A gentleman, wife and daughter would like two rooms, furnished or unfurnished, with board for the summer in a private family. Must be within ten minutes' walk of R. R. station. Address, stating terms, W. M. G., 48 Wright St., City.

2. To Let. A small house, nine rooms and bath, with all modern improvements. Rent, $325 a year. Can be seen between 1 and 6 P. M. 48 Hamilton St.

3. Wanted—A French cart with top. Give full particulars. M. W. G., box 16, Daily Office.

4. House wanted—In 6th ward, near depot, small house for family of two. Rent between $20 and $25. Address, with full particulars, box 49, City.

HOW TO ANSWER ADVERTISEMENTS.

CHICAGO, April 27, 1893.

Dear Sir or Madam:

In answer to your advertisement for a house, will say that I have one answering your description. Cemented bottom cellar with heater; first floor containing a parlor, dining-room and kitchen, the latter having a range, with hot and cold water. Second floor has three rooms, and a bath-room with all conveniences. Third floor has two nice sleeping-rooms. Will rent to a good tenant for $25 a month. Shall be pleased to show you the house whenever you may find it convenient to call,

Yours truly,

R. H. RENTWELL,
42 Jefferson St., City.

FOR A POSTAL CARD.

R. H. RENTWELL, ESQ.,

Dear Sir: Will call to see your house on Wednesday afternoon between 4 and 5 o'clock. Yours, etc.,

THOMAS JEFFERSON.

DIVISION OF FRACTIONS.

When teaching division of fractions, the teacher should proceed just as when teaching division of whole numbers. In both cases we are dividing a number into a number of equal numbers. I ask, $12 divided by $3 equals what? And the answer is 4 (three dollars). I might write it thus: $\frac{12}{\$}$ divided by $\frac{3}{\$}$ equals? The dollar sign does not enter into the operation at all; it simply denominates—*i. e.*, names, the things divided. Again $\frac{12}{A}$ divided by $\frac{3}{A}$ equals?—*i. e.*, how many 3 A's in 12 A's? And the answer is 4 (three A's). $\frac{12}{B}$ divided by $\frac{3}{B}$ equals 4 ($\frac{3}{B}$); $\frac{12}{*}$ divided by $\frac{3}{*}$ equals 4 ($\frac{3}{*}$). $\frac{12}{8}$ divided by $\frac{3}{8}$ equals? Here, as before, the 8 is the namer and should not enter into the operation. The answer is 4 (three-eighths), just as it was 4 ($3), or 4 (3 A's). I ask, $\frac{3}{\text{pints}}$ divided by $\frac{3}{\text{gills}}$ equals? Here my dividend and

divisor have not the same name, which they should have *in all questions in division.* We can make them the same name, as $\frac{3}{\text{pints}}$ is the same as $\frac{12}{\text{gills}}$, and now the question is, $\frac{12}{\text{gills}}$ divided by $\frac{3}{\text{gills}}$ equals? And the answer is 4 (three gills). So, too, when I ask $\frac{3}{4}$ divided by $\frac{3}{16}$ equals?, I have a question where the dividend and divisor are not the same name. I can make them the same name, however, as $\frac{12}{16}$ divided by $\frac{3}{16}$ equals? And here my answer is 4 $(\frac{3}{16})$. I ask $\frac{7}{8}$ divided by $\frac{3}{8}$ equals? and I say $2\frac{1}{3}$ ($3). So, too, when I ask $\frac{1}{3}$ divided by $\frac{2}{3}$ equals? I answer, $2\frac{1}{3}$ $(\frac{2}{3})$. $\frac{3}{4}$ divided by $\frac{2}{3}$ equals? *or* $\frac{9}{12}$ divided by $\frac{8}{12}$ equals? And the answer is $1\frac{1}{8}$ $(\frac{8}{12})$.

From the above, then, we learn that in division of fractions we change the dividend and divisor to the same name and divide the numerator of the dividend by the numerator of the divisor.

Solve the following: (1) $\frac{3}{4}$ divided by $\frac{1}{8}$; (2) $\frac{1}{2}$ divided by $\frac{1}{4}$; (3) $\frac{5}{6}$ divided by $\frac{1}{2}$; (4) $\frac{1}{8}$ divided by $\frac{8}{16}$; (5) $\frac{4}{5}$ divided by $\frac{3}{10}$; (6) $\frac{11}{12}$ divided by $\frac{2}{3}$; (7) $\frac{2}{3}$ divided by $\frac{4}{6}$; (8) $\frac{6}{7}$ divided by $\frac{6}{7}$; (9) $\frac{6}{7}$ divided by $\frac{1}{2}$; (10) $\frac{8}{9}$ divided by $\frac{4}{9}$.

1. Such problems as the following: I have 12 apples to divide among 3 boys, How many will each receive? are problems in partition and should be expressed as follows: Each boy will receive $\frac{1}{3}$ of 12 apples or 4 apples.

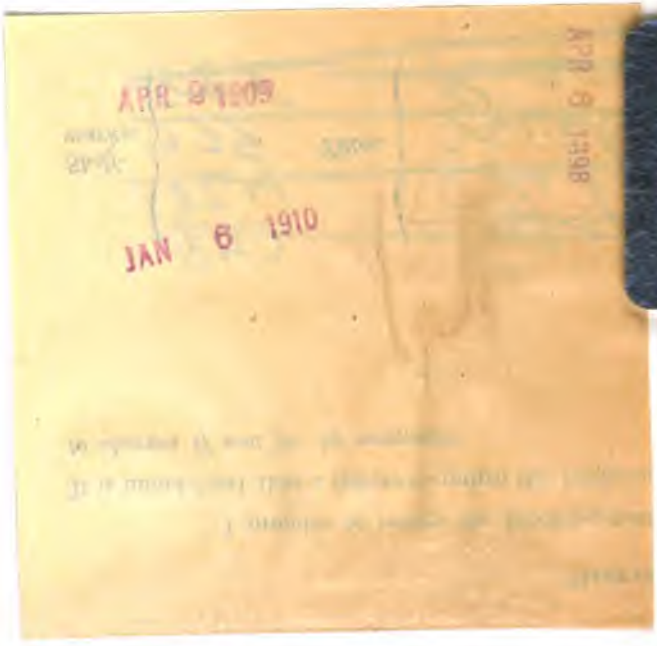
2. What will $\frac{1}{3}$ of a pound of tea cost at $\$\frac{3}{4}$ a pound? Not $\frac{1}{3}$ times $\$\frac{3}{4}$ but $\frac{1}{3}$ of $\$\frac{3}{4} = \$\frac{1}{4}$.

That is, when we divide a number into a number of equal parts to find the number in one part, we call the problem one in partition. The divisor has not the same name as the dividend.

Also wnen both the multiplier and multiplicand (so called) are proper fractions, the question is one in partition.

In multiplication the product is always larger than the multiplicand and always has the same name *i. e.* 3 times $4 are 12 Dollars.

NOTE.—See Parker's Talks on Pedagogics, pages 81 to 106.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